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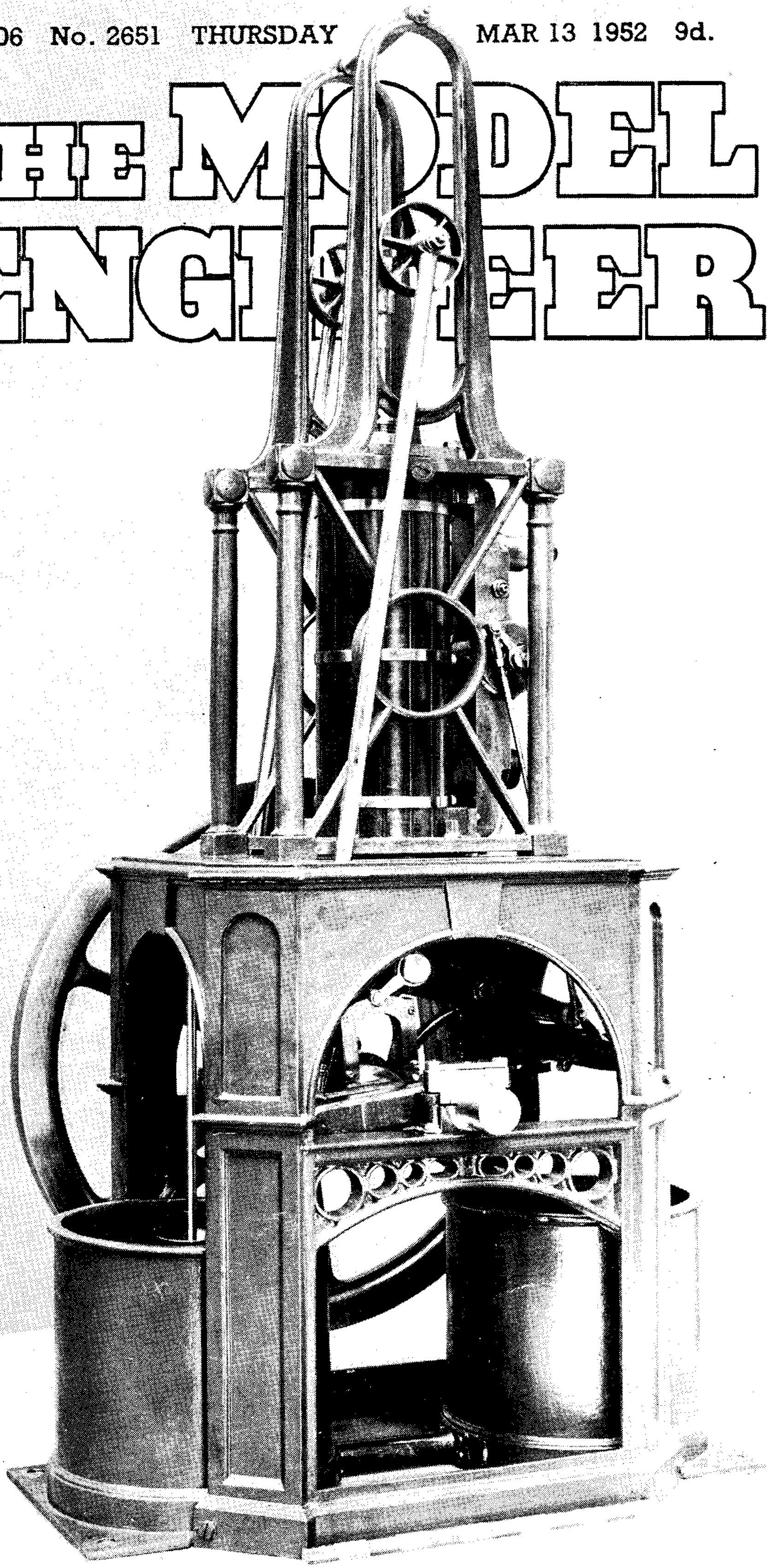
# THE MODEL ENGINEER



# The MODEL ENGINEER

*PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2*

13TH MARCH 1952 VOL. 106 NO. 2651

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# SMOKE RINGS

## Our Cover Picture

● THE PHOTOGRAPH this week depicts an old and interesting relic. The original form of this engine as patented by Henry Maudslay in 1807, is represented by an adjacent drawing, from which the model differs only in detail. Many engines of this kind were made, and until the Lambeth works were closed in 1900, two of them were regularly engaged there in driving some of the machinery.

The cylinder is carried vertically on a cast-iron table, beneath which are two crankshaft bearings and the condensing arrangements. The piston-rod passes through the top cover and terminates in a balancing or articulated crosshead, carrying a pair of wheels which roll between guides formed in an independent framing, secured to the table and the cylinder.

From the crosshead, there are two connecting-rods which proceed to two independent cranks in the crankshaft below. The steam is distributed by a plug-valve rocked by a rod, connecting with a triangular cam on the crankshaft.

The air, cold water and feed pumps are worked by an inverted T-bob driven by a roller on the intermediate portion of the crankshaft.

Crown Copyright. From an exhibit in the Science Museum, South Kensington, London.

## Quality in Workshop Equipment

● READERS OFTEN write to us asking for comparisons between different makes of lathes, or other machine or hand tools. This request is often made "in strict confidence," but if the matter is carefully considered, it will be realised that even if it were possible for us to speak from extensive personal experience of every item of equipment advertised in our columns, any attempt to discriminate in this way would be indiscreet, to say the least. Comparisons of all kinds are odious, and still more in view of the fact that practical requirements vary widely; what we consider to be an ideal tool may not suit the requirements or preferences of our querists. We can, and often do, recommend to our readers items of equipment with which we have had long experience, and are satisfied with their sound quality. For the rest, we can assure readers that all the regular advertisers in the "M.E." can be relied upon to give good value and service for money, if only for the simple reason that unsound goods are soon weeded out under the discriminating scrutiny of buyers, and disappear from the model engineering market. We have always encouraged manufacturers and traders to supply equipment of modest price, to suit the pockets of our readers, but with the emphatic stipulation

that it must be proved capable of the job for which it is designed. The "super" quality tools which are sometimes demanded by readers must necessarily be more expensive than the popular kinds with which most model engineers are content, and which they find adequate to turn out work of the highest quality. Lathes or other machine tools built to special limits of precision are in a similar class; there is nothing so expensive as "guaranteed accuracy" of such equipment. But even where no special claims are made as to limits of precision, we are satisfied that the manufacturers of model engineering equipment have a conscientious regard for the requirements of their customers, and in nearly all cases, serve them well.

## The Topsham Model Engineering Society

● A LETTER from Mr. G. W. Bell, the hon. secretary, informs us that the Topsham Model Engineering Society was formally inaugurated by Major Gould on January 26th, at premises in Ferry Road, Topsham, which have been placed at the new society's disposal by Heywoods of Exeter.

The members, who at present number sixteen, are not newcomers to our hobby, since they can boast of a varied assortment of models, steam, internal combustion, electric, as well as a useful selection of power tools.

The president is Mr. T. Spike, who is known to our readers for his hacksaw, described in our pages, and the fine shaping machine shown at the "M.E." Exhibition last year.

A steam horizontal mill engine, 1½ in. bore by 2½ in. stroke, is being built by the members as a club model; it is being built from scrap material and has a 10-in. flywheel cut out of ⅞-in. steel plate.

The workshop, some 15 ft. square, contains a 5-in. lathe, a 6-in. shaping machine, power hacksaw, a compressor and the usual hand tools, vices and plenty of bench space, power points, etc. There is also a nice slow-combustion stove, a very welcome adjunct in the recent spells of truly wintry weather!

We hope to hear more of this new society's progress; meanwhile we offer it our best wishes for future success and prosperity. Readers in that area, who may be interested in joining, should get into touch with Mr. Bell at his home address, "Riverside," Retreat Road, Topsham, near Exeter.

## A Society at Deal

● WE HAVE received a letter from Mr. R. H. Wright informing us that the Deal and District Model Society has recently been formed. It has its own premises, complete with benches for both woodwork and metalwork; a small forge and fretwork machine are under construction, but, at present, there is only a limited selection of hand tools.

There are two model railway layouts, one for "O"-gauge and the other for "OO"-gauge; the former has well over 120 ft. of track, and steady progress is being made on the fitting up of scenery, landscape, buildings, etc.

The workshop is open on Tuesday, Thursday and Saturday evenings, as well as on Sunday mornings. Meetings are held on the first and third Saturdays in each month. Anyone in the district who may be interested in joining the club can be sure of a warm welcome. Mr. Wright's address is 4, Dolphin Street, Deal, Kent.

## The Northallerton and District M.E. Society

● MR. A. DIXON, hon. secretary of the Northallerton and District Model Engineering Society, took the opportunity, in a recent letter to us, to refer to the fact that the society had existed since February, 1948, and although its members are not very numerous, they are very keen; the youngest is 14 years old.

The clubroom is solely supported by the subscriptions of the members and is open at all times, each member possessing a key; there are wooden benches for those engaged in making aircraft, ships, etc., and a steel bench with vices for the metalworkers. The equipment includes a ½-in. electric drill, circular saw, sanding machine, two fretwork machines and a very useful, if old, 6-in. lathe in very good order. The workshop is in Thirsk Road, Northallerton, in an upstairs loft, where members can be found most evenings and at week-ends; special evenings are Tuesday and Thursday.

Some of the members are engaged in making a 5-in. gauge "Speedy" 0-6-0 tank locomotive, with the object of presenting it to the society, the idea being eventually to raise steam—and funds—as there is already a 100-ft. length of track.

Recently, there was a visit to a newspaper printing works at Darlington, and another to the works of Darlington Forge Ltd., makers of such things as steel mill rolls, ships' rudder parts and crankshafts for ships' engines. It is proposed to visit the Tees Valley Water Board's pumping station at Darlington, where there are three old beam engines of the 1860 period still working and in very good condition.

Mr. Dixon writes: "If there are any lone hands in the district, we offer them the hand of friendship and, may I say, a card of membership."

His address is 10, Hartington Terrace, Northallerton.

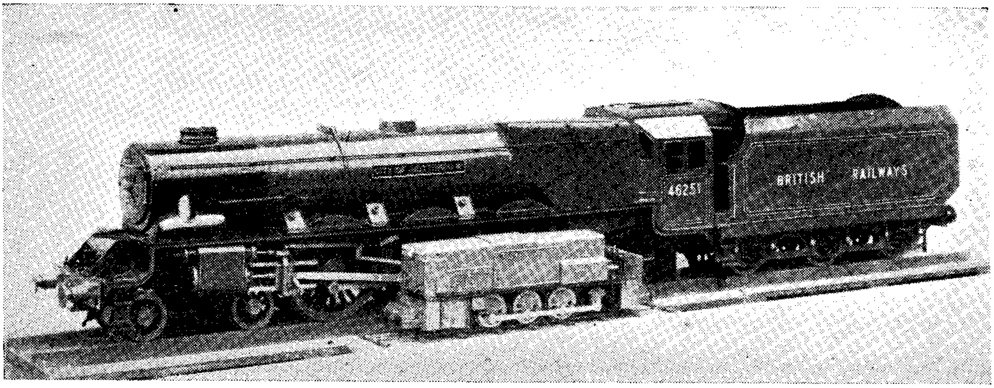
## The Late Mr. John Ayres

● BY THE death of Mr. John Ayres, of Stockton-on-Tees, at the age of 77 years, the Tees-side Society of Model and Experimental Engineers has lost one of its founder members and mourns one who was widely respected as a good friend, and one truly worthy of the title of "Model Engineer."

His name will be familiar to readers of THE MODEL ENGINEER for his prize-winning models of a double-expansion horizontal steam engine at the 1950 MODEL ENGINEER Exhibition.

Mr. Ayres was a retired joiner who had taken up model engineering as a hobby about 35 years ago, when he bought a treadle lathe for £15 and equipped a small bedroom as his workshop. Since that time he built over 100 models of various kinds, including many steam engines and several locomotives.

His late colleagues in the society will miss his presence at their meetings and other functions.




*Comparison of a* 1*-in. scale model* " *City of Nottingham* " *locomotive with the* 1*-in. scale model* 100 *h.p. diesel mine locomotive*

# AN UNUSUAL PROTOTYPE

## F. Surgey describes the building of his 1-in. scale model 100 h.p. diesel mine locomotive

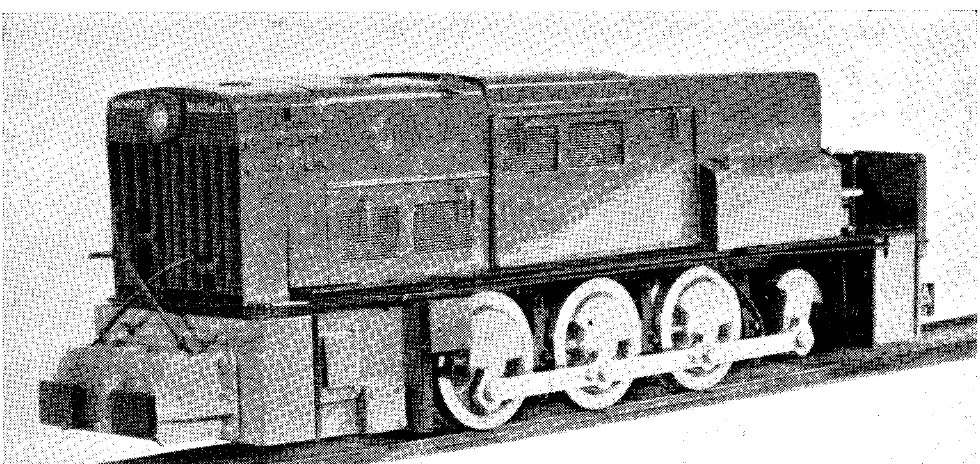
AFTER completing the model of the "Pioneer" type diesel mine locomotive (see the issue of THE MODEL ENGINEER for March 31st, 1949, for an illustrated description), I decided to build a second model of a more recent type.

This new type locomotive is capable of working on 2 ft. gauge track and so is very suitable for a large number of collieries where the track is of this small gauge. Readers may remember the other locomotive was for 3 ft. 6 in. gauge and the rails on which these locomotives run are of very heavy section indeed, so heavy that they are very similar in section and size to ordinary flat-bottomed rails.

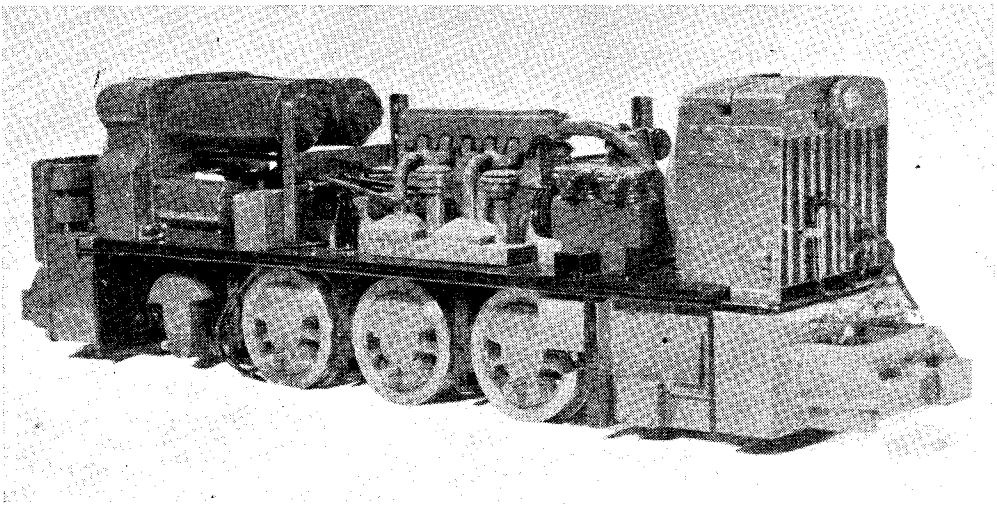
After examining the drawings loaned to me, I decided to build the model to 1 in. scale and as complete internally in the way of dummy engine, etc., as was possible. This, of course, was not to be a working model, but to be well detailed for demonstration purposes.

The main frames were the first job, being cut from $\frac{1}{8}$-in. mild steel plate. Front and rear plates were cut from this size plate, too, the rear cab plate being added later, the whole bolted and riveted together by means of $\frac{1}{4}$-in. brass angle and copper rivets.

The wheels were cast from patterns which I altered from $3\frac{1}{2}$-in. gauge bogie wheels made by



*Front view, showing radiator grille and exhaust conditioner tank*



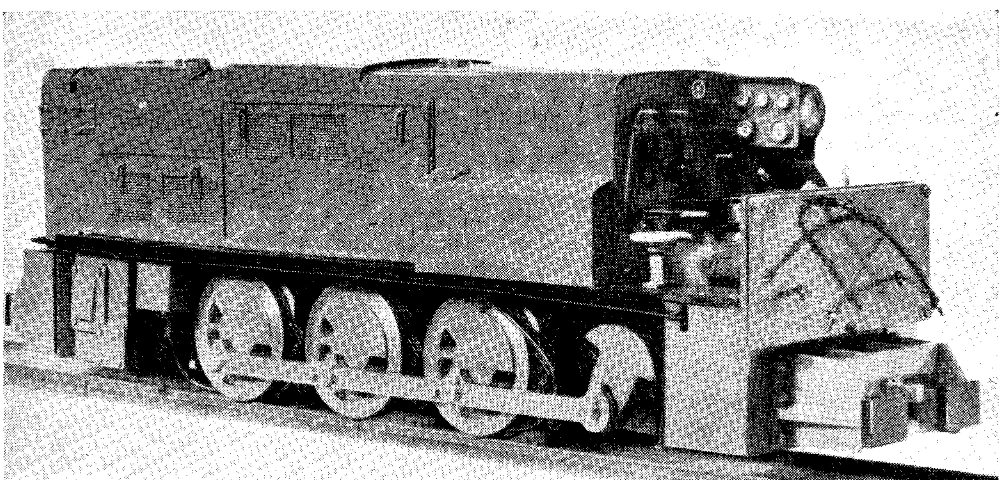
*The model under construction before fitting the bonnet*

the simple expedient of filling in a number of the spokes with white metal and filing to shape. The resulting pattern was very satisfactory, and so the castings were duly turned and drilled for crankpins.

The cranks on the end of the jackshaft were turned from mild-steel and cut to shape, axles being fitted to wheels and cranks. These axles, turned from $\frac{5}{16}$-in. bright mild-steel, were located in slots cut in the frames and held in position by plates bolted to the frames. These wheels are not required to revolve, so it was decided to fit them this way for simplicity and to make them easily detachable as the model progressed. Crankpins were turned and fitted, the holes for the collars which fit on the outer ends of the crankpins were drilled later. These collars are fitted with small taper pins filed from $\frac{1}{16}$-in. steel wire. The connecting-rods were hacksawed and filed from $\frac{3}{16}$-in. mild-steel plate. The exhaust conditioner tank and its fittings were then built into the forward end of the frames and the large weight fitted on the actual locomotive for adhesion purposes was made and bolted to the front frame plate. Another plate of $\frac{1}{4}$ in. thickness was bolted to the rear cab plate.

The buffing and coupling gear on these locomotives differ according to the type of mine car the locomotive is to haul, and so this type was decided upon and is built up from 3/32 in. and $\frac{1}{8}$ in. brass plate.

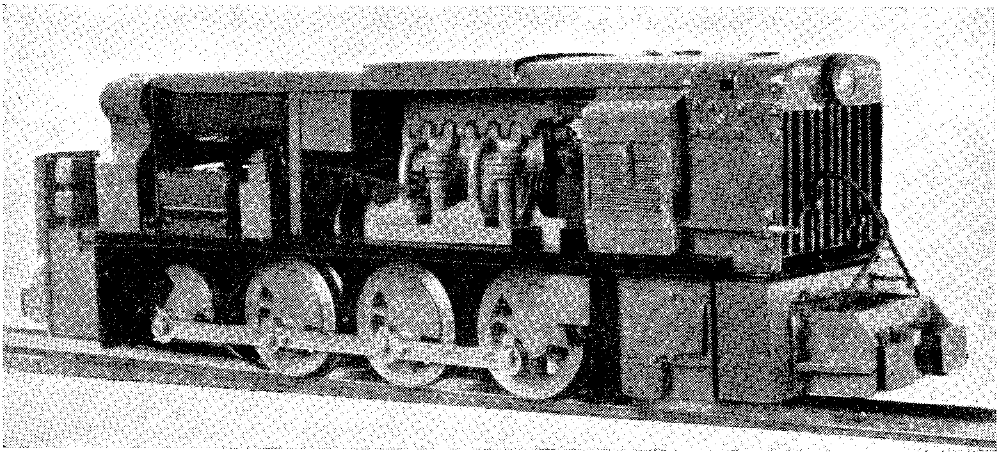
Brake gear was built up next and the brake



*View from cab end, showing controls and instrument panel*

blocks were cut from a ring turned to the desired shape. Hanger brackets were riveted on the frames, the rods being coupled together by means of shackles and nuts cut from hexagon bar. In addition to the hand brake, the wheel of which can be seen clearly on the left-hand of cab, these locomotives are fitted with a compressed air cylinder between the frames at the rear of the exhaust conditioner tank.

This cylinder was turned from brass and its piston coupled to the brake-rods by a series of levers and cranks. Sand tanks were made and with miniature valves can be seen on the cab frontplate, together with a group of instruments on the right-hand side. These miniature valves are fitted with hand-wheels made from watch wheels and look very realistic. The rear light can be seen just behind the instrument panel, but on more recent models has been fitted to the centre of the rear plate, and looks much better. The sand valve and compressed air brake valves are fitted to this rear plate, the handles of which can be seen just protruding above the rear plate in the photograph.



*Side view, showing bonnet cut away to see engine, fuel tank and compressor tanks*

fitted to the frames and footplate, and the special type Westinghouse sand valves made up from brass, fitted with copper tubes for the sand pipes.

Work was then begun on the engine and transmission. The engine is a dummy replica of the 100 h.p. Gardner type and is shaped from wood, and fitted with air intakes, filters, fuel pump compressed air starter motor, and exhaust pipes, all cut and turned from brass. Piping was made from copper wire ; unions made from 9-B.A. hexagon nuts were soldered in position.

The fluid flywheel and couplings to gearbox were turned from mild-steel. The gearbox body was made from wood, while its levers and fittings were cut from brass and fitted on.

At the forward end is the radiator grille, the radiator itself and then the fan. These were built up from brass plate and bar, the headlight being fitted at the same time. The fan shaft runs in a frame and is driven by vee-belts from a pulley on the front end of the engine. The dynamo is also attached to this frame and is driven by a vee-belt from the fan shaft. A pipe was cut from tube, bent, and fitted with flanges to run from the engine exhaust pipe to conditioner tank. These flanges are bolted together by 14-B.A. bolts.

Also at the forward end is the dummy compressor made from brass, which is again driven by vee-belts from the engine pulley. Various fittings and pipes for this compressed air system were made from brass and copper wire while the four tanks in front of the cab plate were made and fitted in position. Pipes coupled to these, fitted

Twin air brake pipes from flexible wire driving bands are fitted to both front and rear of locomotive, the coupling ends hanging from light chain.

Control levers and cranks for operating gearbox and engine were cut and turned from brass, and coupled to their corresponding mechanisms.

The fuel tank, fitted in front of the compressor tanks, was mounted on a frame of $\frac{1}{4}$-in. brass angle which was in turn screwed to the footplate. A similar frame holds in position the water tank, which is fitted above the radiator fan shaft. A coupling pipe runs from this tank into the engine exhaust pipe.

After many months of work the model was ready for painting and so it was dismantled to facilitate this, but before doing so measurements for the bonnet were taken. The bonnet was cut from sheet tin, one side being open while the other side is fitted with a detachable door so one can see the opposite side of the engine.

This was mainly soldered together, the ventilating spaces being cut in and fine brass gauge being soldered behind. It was made so that by undoing several bolts, the bonnet can be lifted completely clear as a unit.

The scheme adopted for painting was such that it would clarify the various sections of the locomotive for demonstration purposes.

The compressed air system comprising cylinders, pipes, valves horn and compressor, were painted blue, while the engine, transmission and gearbox, were red. The exterior of the loco-

motive was finished in green and black paint.

The whole completed model was clamped firmly on to a length of flat-bottomed track on a polished baseboard. The time taken for building this model was nearly two years, though some of this time was taken up on the construction of the model motor-cycles described in a previous article.

I must mention the kind assistance afforded by both the Huwood and Hudswell-Clarke Companies in the loan of excellent photographs and drawings.

# EFFICIENCY

## by W. S. Laycock

LOOKING through some old issues of THE MODEL ENGINEER, I unearthed a definition of "efficiency" as : $\frac{\text{work got out,}}{\text{work put in}}$ with a remark to the effect that the term is used very loosely in model engineering circles. With this in mind, a few facts and figures on the subject would not come amiss. It may be due to natural reticence, or to the difficulty of making the necessary experiments, but whatever the reason, the fact remains that published figures on fuel consumption for a given power produced are as rare as snowballs on the Sahara ; so here we go with my own observations in this field.

A 7.5 c.c. twin-piston two-stroke of my own design (described in THE MODEL ENGINEER for November 16th, 1950) developed 0.36 b.h.p. whilst consuming fuel at the rate of 4 c.c. per min.

Now 4 c.c. = approx. $\frac{1}{125}$ pint.

1 pint of fuel has a calorific value of 17,000 B.Th.U.

1 B.Th.U. = approx. 780 ft./lb.

so that we are putting into our engine about $\frac{17{,}000 \times 780}{125}$ ft./lb. per minute, whilst we are getting from it 0.36 × 33,000 ft./lb. per min. ; the overall thermal efficiency as a percentage, therefore, is of the order of :

$$\frac{0.36 \times 33{,}000 \times 125}{17{,}000 \times 780} \times 100$$

or about 11.2 per cent.

This is definitely not a high figure when compared with the full-scale figure of 30 per cent. plus, but it would be interesting to know how it compares with the general run of model i.c. units. In this connection we may get some sort of figure from Mr. Deason's book *Motor Racing in Miniature*. He gives an approximate consumption for a 10 c.c. model car of 60 miles per gallon. Assuming 90 m.p.h. and 1 b.h.p., we finally arrive at an efficiency of approximately 1 per cent. ! Not very impressive, is it ?

Another approach comes to mind. Whilst investigating the possibilities of petrol injection, I calculated that for a 10 c.c. engine I should require about 1 cu. mm. of fuel per stroke. If we assume that such an engine would develop 1 b.h.p. at 20,000 r.p.m. we can again calculate a hypothetical thermal efficiency :—

Fuel consumed per min. = 20,000 cu. mm. = 20 c.c. = 1/25 pt.

$$\text{Power input} = \frac{17{,}000 \times 780}{25} \text{ ft./lb./min.}$$

Output = 33,000 ft./lb./min.

$$\text{Efficiency} = \frac{33{,}000 \times 25}{17{,}000 \times 780} \times 100$$

= 6.2 per cent. approx.

In the steam locomotive field, full-size figures rarely reach 5 per cent., a fact which may occasion some surprise to more than a few of our brethren. I myself have no figures for steam units either stationary or mobile, but I would not be in the least surprised to learn that one of "L.B.S.C.'s" "real little engines" would exceed the efficiency of its full-size prototype. To check on the efficiency of a small locomotive, we must know the same facts that were required in the cases given above for i.c. engines. We must also remember that in the case of the locomotive, we do not take the total load pulled, but the pull at the drawbar. So we interpose a spring balance between the locomotive and its load, and run around for a while on a level closed-circuit track ; we measure the distance covered, the time taken, and the weight of fuel consumed. We must also, of course, take a note of the pull in the spring balance :

Then work got out =

$$\frac{\text{distance in feet} \times \text{pull in lb.}}{\text{time in min.}} \text{ ft./lb./min.}$$

And work put in =

$$\frac{\text{lb. fuel used} \times 14{,}000 \times 780}{\text{time in min.}} \text{ ft./lb./min.}$$

so that the time factor cancels out, leaving :

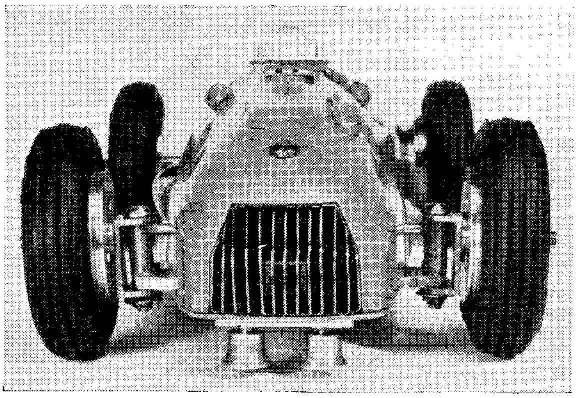
$$\text{Efficiency (\%)} = \frac{\text{distance in ft.} \times \text{pull in lb.}}{\text{lb. fuel used} \times 14{,}000 \times 780} \times 100$$

I should very much like to see results of such tests, which could very well be carried out by many of the small locomotive societies up and down the country.

The small locomotive has one great advantage over the full-size job, in that its weight is grossly over-scale, and, therefore, its adhesion is much better. This in my opinion is the greatest single factor in the matter of the amazing loads which these models shift. For example, a $3\frac{1}{2}$-in. gauge locomotive ($\frac{1}{16}$ full size) should have a scale weight of $(\frac{1}{16})^3$, or $\frac{1}{4096}$ of full-size. This means for a $3\frac{1}{2}$ in. L.M.S. "7P" *Princess Royal* with tender, the scale weight would be 87 lb. ready to run ! From memory, I believe, such a model is at least 50 per cent. in excess of this figure.

In conclusion, I would comment that although we may try to convince ourselves that efficiency as such does not concern us, the fact remains that at least in the case of i.c. engines our efforts can in no way be labelled "efficient" ; amazingly powerful, perhaps, but certainly not efficient, and the sooner we drop the horrid word the better.

# A MODEL GRAND PRIX IN SWITZERLAND



*Note the robust king-pins and bush housings*

THE accompanying photographs show one of the models which operate on the Swiss model Grand Prix circuit at Geneva.

When the owner-builder, Mr. Pierre Chevrot, wrote to us a short time ago asking for particulars of M.G.P., we had little idea that we would, at such an early date, be given the opportunity to taste of the fruits of his labours. He is to be congratulated on his very neat layout of this 1/12th scale Talbot.

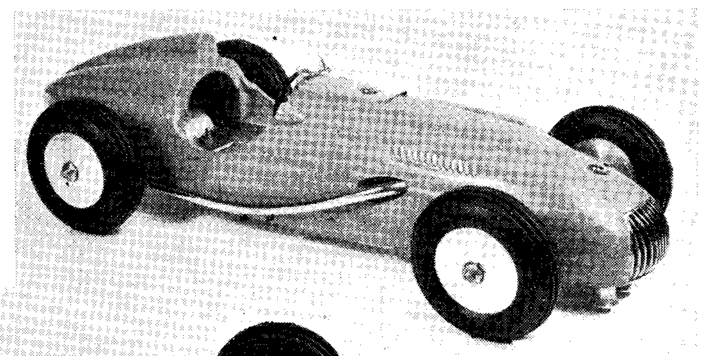
As can be seen from the photographs, the model incorporates a central longitudinal member for extra rigidity of the chassis assembly, and Ackerman steering. The latter appears to be particularly robust, and should stand up well to the general wear and tear of fast, tight, cornering.

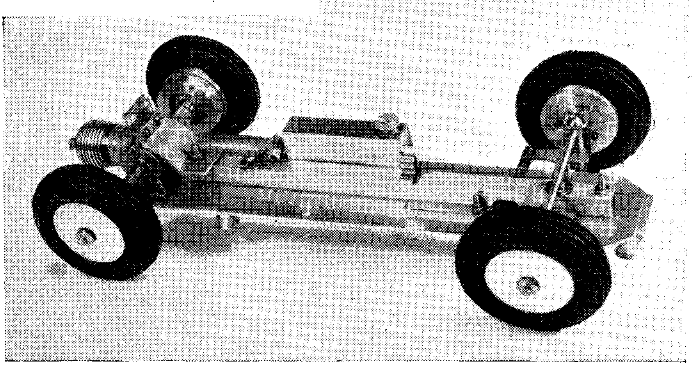
The bodywork, in wood, has been very nicely carried out and with the seat and driver in place would present an admirable impression of realism.

We shall look forward to hearing a great deal more about the activities of our Swiss friends, and we hope that it will not be long before arrangements can be made for the holding of Model International Grands Prix. We shall be pleased to hear from any of our readers who are interested in such a proposition.

We would remind readers that we are able to supply a complete set of full-size drawings, to 1/12th scale, of the famous 158 Alfa Romeo, adapted for Miniature Grand Prix by the well-known motor racing expert, Mr. Rex Hays. These, at 7s. 6d. net the set, and outline drawings of a number of other famous Grand Prix cars, may be obtained from our Plans Department.

*Right—Before driver and seat were fitted*





*Left—A simple, yet efficient, chassis layout*

# BALANCING SMALL ENGINES

## Notes on basic principles and practical methods of procedure

### by Edgar T. Westbury

EVERY new development in engineering brings with it new problems, or causes old problems to become accentuated, and it is often found that the methods of dealing with them have to be revised to cope with advanced design and more exacting performance. While engineers of today are very fortunate in having available a vast amount of accumulated data, obtained laboriously by the research workers of the past, it is often found that this is inadequate to cover the conditions which arise when producing something entirely new, such as, for instance, a racing engine. In some respects, one may be hampered rather than assisted by faith in ready-made data, and it is often better to tackle the problems from first principles, or even by the much-despised " rule of thumb," which although crude, is often effective.

A problem which is brought to my notice with ever-increasing frequency these days is that of balancing engines or other mechanism. Many readers who attempt to construct engines which will go just a little faster than ever before, find themselves in trouble with excessive vibration or overloading of working parts, as a result of unbalanced forces, and ask my advice in finding a practical solution. Some of them are rather disappointed to learn that I cannot furnish them with a few figures and symbols which will clear the whole matter up tidily and accurately ; the childlike faith which some of my querists have in formulae is most impressive !

It is perhaps necessary for me here to make one of my frequent disclaimers regarding my attitude to theoretical solution of problems. I am not, nor have I ever been, antagonistic to, or contemptuous of, theory, wherever it can properly be applied ; but the factors involved in what may, at first sight, appear to be quite a simple practical problem, are often so profound and complex that their solution by theory alone is almost impossible to a person of normal intelligence. By all means use theory in its place, and where you can be quite certain that the premises on which it is based are correct ; but always remember that it must be a supplement to, and not a substitute for, practical knowledge. In many problems, practical experiment will find the solution more quickly and no less accurately than theoretical calculation.

So far as the particular subject of balancing is concerned, I may mention that many years ago, in the attempt to solve problems personally encountered, I studied text-books by three of the best-known authorities on the subject namely, Sharpe, Dalby, and Schlick ; but I must confess that, so far from being enlightened, I was scared stiff with the immensity of what I had regarded as a mere elementary problem of design.

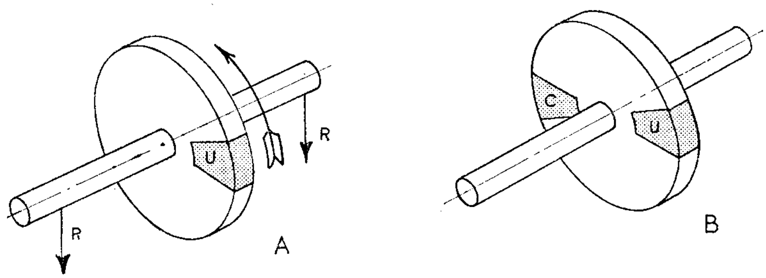



*Fig. 1. A disc having an unbalanced mass " U " can be balanced by adding a counterweight " C "*

#### First Principles of Balancing

The need for balancing arises by reason of the basic law of mechanics which states that " Action and reaction are equal and opposite." Any force which tends to produce motion in a body must therefore be balanced by an equal reactive force. For instance, water or air craft in moving through a fluid, must necessarily produce a reaction in the opposite direction against that fluid ; motorcars or locomotives produce a backward reaction on the road or track, through their driving wheels. A revolving shaft which exerts force to drive a machine is subject to " torque reaction " which is equal and opposite at all times to its driving torque. If a piston, in an engine or pump, moves upwards, under the effect of a given force, an equal downward reaction is exerted, through the connecting-rod and crankshaft, to the bearings and foundation of the machine. This brief explanation of what reaction really means may not be necessary to the majority

of readers, but it has been considered worth while in case of any possible misunderstanding of the term.

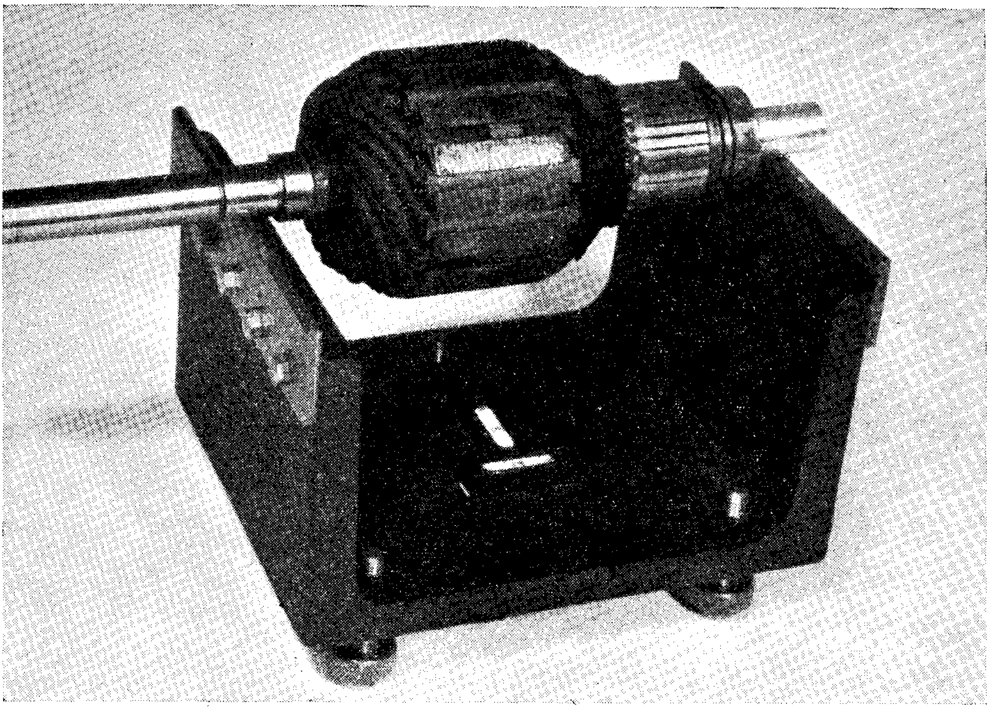
Perfect balance in a machine requires that the reaction of the forces required to accelerate the working parts, or keep them moving against load, should neutralise each other in every phase of the motion, so that no reaction is ever exerted upon the bedplate of the machine. Such a machine would run steadily and without vibration at any speed, without the necessity for bolting down. It may be said that this desirable condition is rarely, if ever, obtained in practice, and one must be satisfied with the nearest approximate condition which can be obtained within the limitations of practical design.

## Balancing Revolving Masses

A truly symmetrical wheel of homogenous material, mounted on a true shaft and running in properly fitted bearings, produces no unbalanced forces, except for torque reaction, which is generated when it forms part of a machine used either to exert or absorb power; this is a matter with which we are not at present concerned. But it often happens that the mass of such a wheel cannot be guaranteed symmetrical, even when it is machined all over, and any lack of mass symmetry introduces an unbalanced force, the reaction of which tends to produce vibration of the frame carrying the bearings of the wheel as shown in Fig. 1A. If the unbalanced mass $U$ is on the side of the wheel which is travelling upwards at a given time, the frame is subject to a downward reaction $RR$; and at any phase in the revolution, the effect is always felt on the frame, in an opposite direction to the unbalanced force. The speed of rotation will affect the vibration caused by these reactions, which may become violent and dangerous at high speed.

If the foundation of the bearings is held rigidly, it is sometimes possible to prevent vibration becoming apparent, but the forces are still there, and are exerted on the bearings of the wheel, thereby causing excessive loading. On the other hand, the frame may be resiliently mounted, so that vibrations are damped out to a certain extent between the machine and its actual foundation; but in neither case is this a complete remedy for lack of balance.

The logical and obvious thing to do in this case is to correct the bias in the mass of the wheel, either by removing metal at the heaviest point, or by adding a corresponding amount of mass at a point exactly opposite to it as in Fig. 1B. In order to locate the position of the unbalanced mass, and also to check any correction made, the wheel may be "poised," by rolling the shaft on levelled knife-edges, rollers, or very free-running bearings, and noting any tendency for it to stop in one position; the unbalanced mass will, of



*A simple stand with adjusting screws and two-way level, for static balancing of small rotors*

course, tend to run by gravity to the lowest point. This method of static balancing is often employed in practice, but where high accuracy is necessary it tends to be tedious and sometimes expensive.

A simple stand for the static balancing of flywheels, armature shafts, etc., is shown in the photograph. It was made from a piece of channel

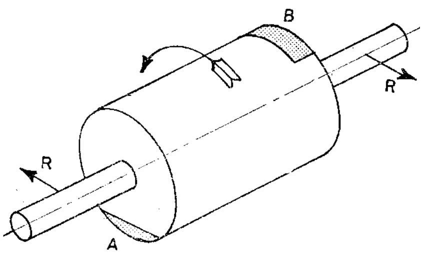


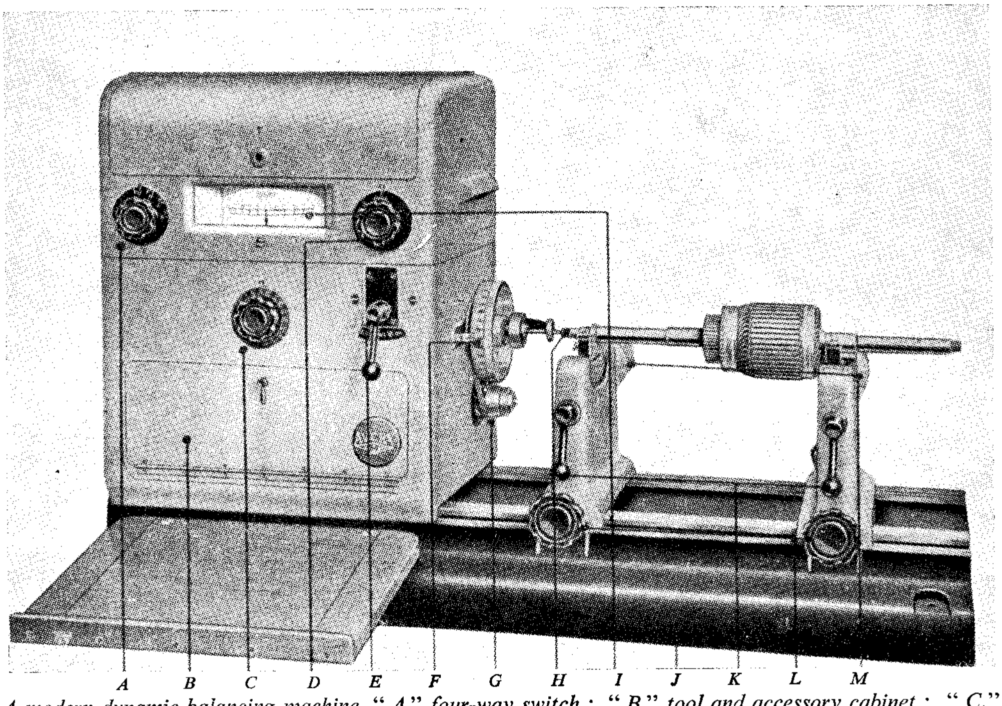

*Fig. 2. A cylinder having opposed unbalanced masses "A" and "B," may be in static balance, but is still dynamically unbalanced*

steel, with strips of gauge plate bolted to the upturned edges, and is provided with three levelling screws in the base, and a two-way spirit level. The strips are not finished to a sharp edge on the top surface, but are honed to a radius to avoid damaging shafts or mandrels, and must, of course, be dead straight and in parallel alignment with each other.

**Static and Dynamic Balance**

So far we have considered the case of a wheel, which approximates to a simple disc, having all its mass in or near one plane. If this is statically balanced in the way described, it will run at any speed without vibration. But in a rotating body having a fairly considerable axial length, such as a cylinder, it is important that any local unbalanced mass should be balanced out by a mass as nearly in the same cross plane as possible. The static method of balancing, in this case, is not reliable, because it gives no indication of the position of the bias in relation to axial length. Thus the cylindrical rotor, an armature shaft for instance, shown in Fig. 2, may be heavy at the point *A*, as indicated by a static balancing test. If this unbalanced mass is counteracted by a weight applied at the point *B*, the rotor will appear to be in correct balance ; but when running at high speed, the effect of the two unbalanced masses will cause local reactions *RR* which tend to rock the shaft along its length, or in other words to set up a "couple." In practice, the effect of this may be worse than that of a single unbalanced force which tends to vibrate the structure bodily, and it is often much more difficult to detect and correct.

The method usually employed for dynamic balancing is to mount the shaft in bearings on a frame which is resiliently mounted, usually by some form of spring suspension, so that it is capable of being displaced in any plane by the




*A modern dynamic balancing machine. "A" four-way switch ; "B," tool and accessory cabinet ; "C," angular control knob ; "D," sensitivity range ; "E," motor switch ; "F," angular disc ; "G," slipping clutch to protect drive ; "H," driving sleeve ; "I," unbalance indicator ; "J," heavy solid baseplate ; "K," locking handles ; "L," traversing adjustment ; "M," pick-up units*

*(By courtesy of Messrs W. T. Avery Ltd)*

effect of unbalanced forces. Means are provided for locking the frame while the shaft is run up to a fair speed by any convenient means, after which it is released and allowed to vibrate or oscillate under the effect of the unbalanced forces. In modern dynamic balancing machines, indicating or recording devices are provided to show the position and extent of the unbalanced masses.

While it would not be impossible to construct

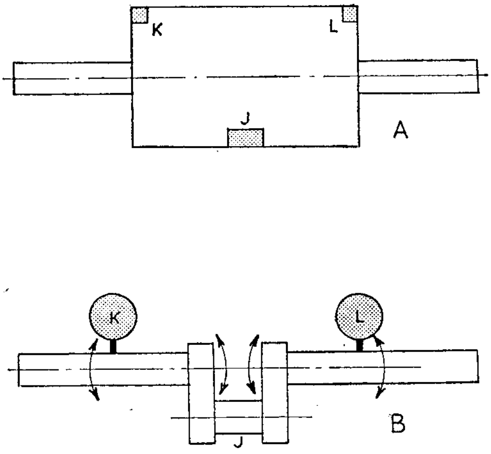



*Fig. 3. A solid rotor may be in dynamic balance as at "A," but in a rotor capable of deflection, the arrangement at "B" may be unsatisfactory*

a simple dynamic balancing rig in the home workshop, most of the problems involved in small machines can be dealt with by careful consideration of design, and accuracy in construction of moving parts. It may be mentioned that even the balancing machine, unless of very complex design, may leave certain important considerations out of account. For instance, suppose that a rotor having an unbalanced mass at *J* (Fig. 3A) is balanced by adding two smaller masses at the points *K*, *L*. The rotor is then in correct dynamic balance, and in the case of a fairly rigid component, such as an armature, it will be perfectly satisfactory in practice. But suppose the same principle is applied to a non-rigid component, such as a crankshaft; in this case, the cancelling masses, being in different planes, exert bending stresses on the shaft, and the latter may be deflected, thereby altering the moment of the masses and putting the system out of balance. (Fig. 3B.)

This is only one of the many pitfalls in practical balancing, which cause the designer many headaches, and are rarely capable of being dealt with by theoretical calculation. Another example occurs in the case of a rotating body which for practical reasons cannot be made symmetrical in shape, though the moments of mass are calculated and counterweights added where necessary to cancel out and give correct balance as in Fig. 4. When running at high speed, however, the effect of centrifugal force causes the flywheel to distort, and thereby displace the masses to a varying extent, thereby unbalancing them. In case readers think this is an unlikely eventuality, I may say that I once worked on a certain type of flywheel magneto which gave a great deal of trouble through this cause, though dynamic balancing tests gave no indication of the source of error.

Balance weights, whatever their type or purpose, should always be located as close to the plane of the unbalanced mass as possible. Thus, in the case of the crankshaft shown in Fig. 3B, it would be better to attach the counterweights to the crank webs than at the points indicated. The practice of fitting balance weights to external flywheels, therefore, is one that cannot be commended; in the case of an overhung crankshaft, any bias in the flywheel would set up a violent rocking couple. Flywheels should always be at least in static balance, and if of any great width, dynamic balancing is desirable. An exception is made in the case of internal flywheels, as in motor-cycle engines, which are close to the crankpins, and usually form the crank webs.

**Balance of Reciprocating Masses**

We have seen that an unbalanced rotating mass may be cancelled by an equal and opposite rotating mass; in a similar way, an unbalanced reciprocating mass may be cancelled by an equal and opposite reciprocating mass. It is essential that this axiom should be clearly understood; it is no use attempting to balance completely a reciprocating mass by a rotating counterweight, or vice versa. A reciprocating mass can only be balanced by an equivalent mass moving in the same plane, but in exactly opposite phase. Thus it happens that the most popular

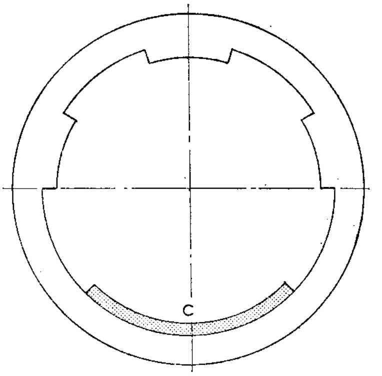



*Fig. 4. An unsymmetrical rotor, balanced by a counterweight, may become unbalanced by distortion caused by centrifugal force*

type of small engine, having a single piston working on a single crank throw, cannot possibly be perfectly balanced; the best that can be done in practice is to use a rotating counterweight to produce a partial state of balance, which may be more or less satisfactory, but can never eliminate vibration or abnormal mechanical stresses completely.

*(To be continued)*

# Components for a Vertical Milling Machine

## by F. Butler

IT is rarely that an engineer remains wholly satisfied with the performance of his lathe when employed on milling and drilling operations. Setting up is tedious, heavy cuts are risky and it is difficult to accommodate large or awkward jobs. A good milling machine is an expensive investment and is almost impossible to build without access to another machine of the same type. The following notes give some general information on a model now under construction, as well as some more specific details of various components which have already been completed. The main elements such as slotted tables, hand-wheels, pulleys and long feed screws were obtained second-hand at prices far below those at present charged for unmachined castings or ground steel shafting. Gear wheels, pinions and ball-races were bought on the surplus market, from garages or from car-breakers' yards. High-tensile steel bar came from similar sources.

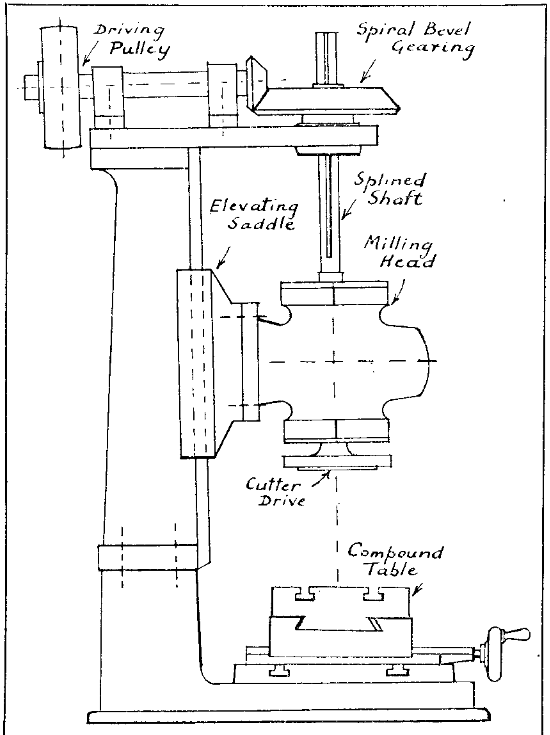



*Fig. 1. Vertical milling machine—general arrangement*

It is no doubt presumptuous to write about any such equipment before a prototype has been completed, and the only excuse for doing so is that a critical reader may come forward with expert comment on some feature while this is still in the idea stage and before the error has been perpetuated in cast iron.

### Choice of Type of Machine

One can debate at length the relative merits of vertical and horizontal milling machines. For production work the latter type is more commonly used, but the vertical machine has much in its favour from the model engineer's point of view. It can be used for heavy drilling and tapping, for jig-boring, side, face and end milling, keyway cutting, machining vee-slides and cutting T-slots. It is readily adaptable for use with single point fly-cutters and can be designed to deal with large work-pieces, while permitting close observation of the work in progress. For these reasons it was decided to start operations on this particular type.

The proposed general arrangement is shown schematically in Fig. 1. The pedestal base, from a Herbert vertical drill, carries a compound table and also supports a machined column along which the elevating head is arranged to travel. The main spindle is provided with a long, splined extension and is driven by spiral bevels from a horizontal shaft at the top of the machine.

Fig. 2 shows the main components of the equipment as purchased. The group includes all parts except the vertical column, the cross-slide and saddle, and some minor details of which the design has not yet been settled.

### Design and Construction of Vertical Head

The traversing spindle of a vertical mill or boring machine is commonly fitted to a quill similar to that of a drilling machine. This is a convenient arrangement but it lacks rigidity, so that in the present machine the entire head is arranged to slide on the vertical column. Fig. 3 is a photograph of the dismantled spindle and housing, while the assembled head is illustrated in Fig. 4. The casing is machined from the cast-iron body of a large water-valve, while the spindle is formed from an alloy steel forging which was originally the propeller shaft of a motor truck.

The machining operations call for very little comment. The casing was held in a heavy four-jaw chuck and was bored and faced at one

setting, using a rigid boring bar held in the top-slide of the lathe. The combined overhang of both job and boring bar caused some apprehension, but it proved possible to take very heavy cuts after the top scale had been removed. Some idea of the requisite operations may be obtained by reference to Fig. 5, which shows a cross-section of the finished head. The rear face of the casting was machined by mounting the work between centres on a short stiff mandrel.

The working spindle carries two heavy duty ball bearings of the journal type for radial loads and a large thrust race is provided to deal with axial forces. It was desired to keep the material of the spindle in its original heat-treated form, in which state it first appeared almost unmachinable.

Further tests showed that a Mitia brand carbide tipped tool would stand up to the work, although a heavy cut soon stalled the lathe driving motor. This is alleged to be a certain way of fracturing the tool tip, but no such untoward result was experienced. It was found necessary to support the job in a fixed steady, and to mount the lathe tool with the minimum possible overhang. The spindle was finish ground and four driving splines milled in it, through the good offices of a colleague. The ball-races were then fitted, being lightly shrunk into position, after which the entire head casing was heated and the spindle pressed into place. Extreme care was taken to maintain the closest possible tolerances on all critical dimensions.

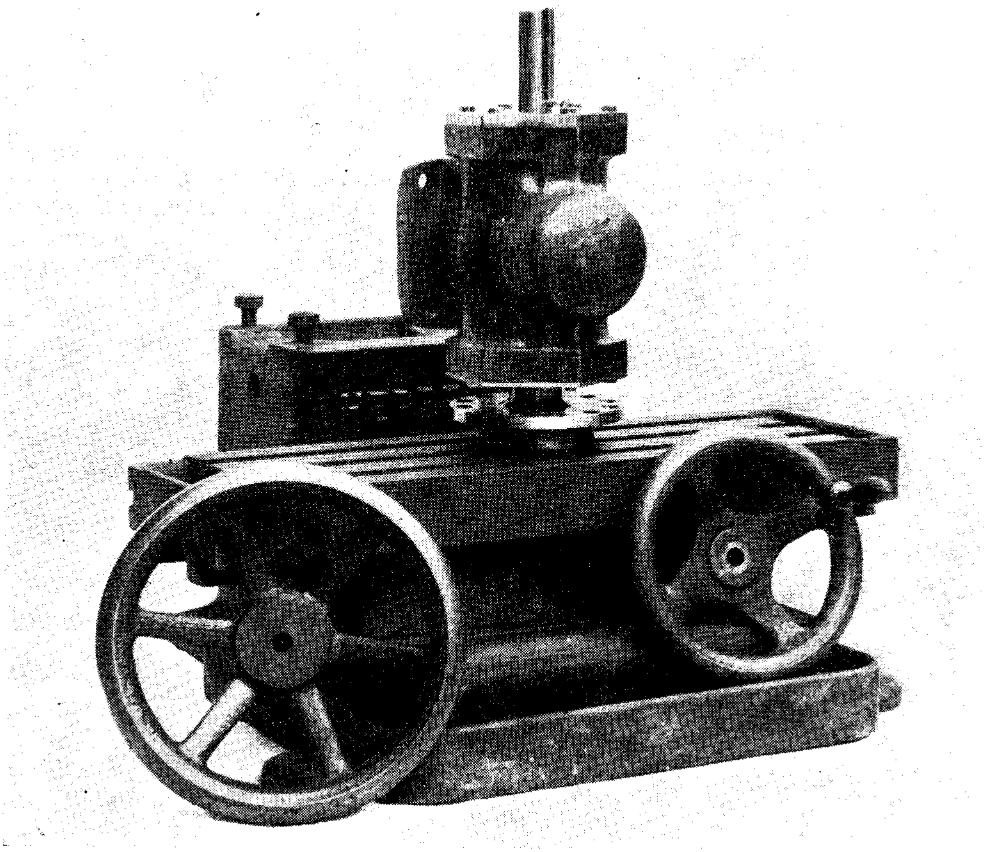


*Fig. 2. Main components of machine*

Reference to Fig. 5 will show that a cover plate is fitted to the casing at the working end of the spindle. At the other end, a separate cast-iron housing is provided for the smaller ball-race, grease nipples being fitted where necessary.

Tests on the finished head proved very gratifying. There is no detectable radial or end play in the bearings, shaft eccentricity is less than 0.0002 in. and the spindle is straight, over the whole length, within 0.0015 in.

The spindle is bored No. 2 Morse taper and the end is formed into a spigoted faceplate, integral with the shaft. In this way, chucks and adjustable boring heads may be fitted rigidly,

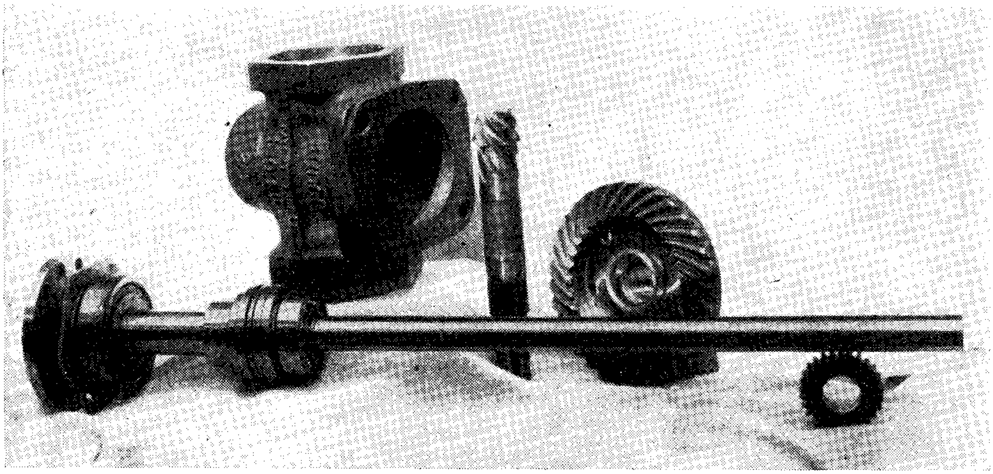


*Fig. 3. The dismantled milling-head*

although it is admittedly an inconvenience when performing certain operations in restricted spaces, where the 4-in. faceplate is liable to get in the way or to obstruct the view. A machined side flange on the casing serves to fix it to a separate sliding saddle on the vertical column, using four $\frac{3}{8}$-in. high tensile bolts. Tests with a high-grade dial indicator show that the plane of the mounting flange is parallel to the spindle axis within 0.001 in. per foot run, although in practice this accuracy cannot be maintained in the finished machine due to spring under the influence of a heavy cut. This statement is true of most machines, and claims for their accuracy must be related to the depth of finishing cuts employed on specified work-pieces.

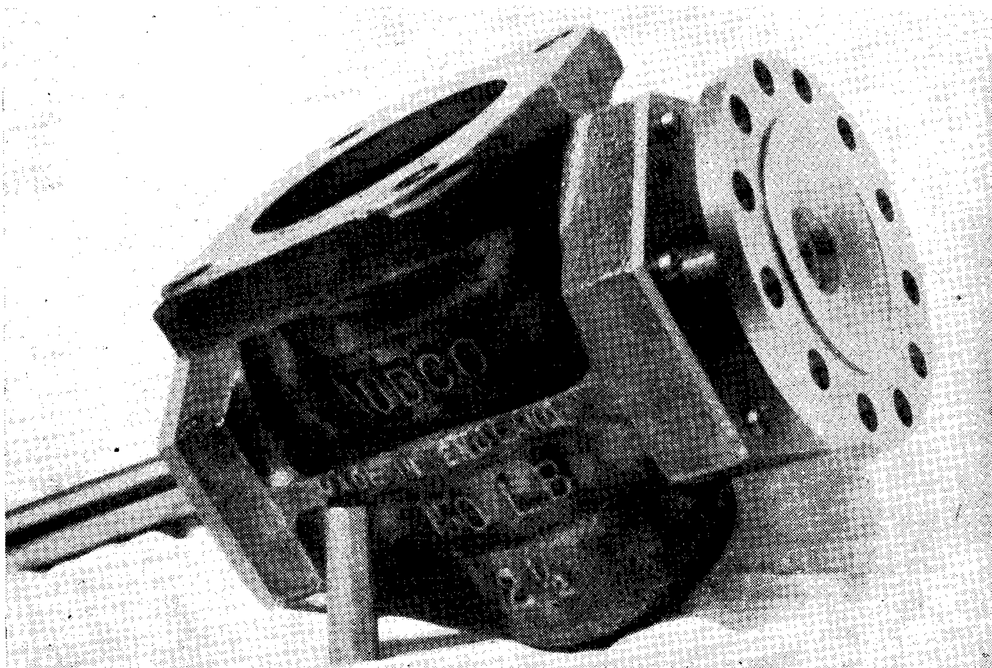


*Fig. 4. The milling-head assembly*

A few of the leading dimensions of the milling head are given below.

| | |
|---|---|
| Overall length of spindle .. .. .. | $25\frac{3}{8}$ in. |
| Maximum diameter .. .. .. .. | $1\frac{7}{16}$ in. |
| Minimum diameter .. .. .. .. | 0.990 in. |
| Faceplate diameter .. .. .. .. | 4 in. |
| Overall length of cast housing .. .. | $6\frac{1}{4}$ in. |

The meticulous reader will note that the drawing (Fig. 5), violates some of the draughtsman's accepted conventions. The "mistakes" are deliberate and have been made in order to clarify the sketch.

A considerable amount of pattern making and heavy machining remains to be completed, including the main saddle, vertical column and driving head. None of this calls for unusual operations and most of it must be put out to contract. The spindle drive mechanism has not yet been fully thought out, although it is unlikely to present much difficulty. It is hoped later to provide a photograph of the finished machine and to give a few details of its performance.

In conclusion, it is of interest to remark that the three photographs came to be taken by the writer as a result of articles and correspondence in THE MODEL ENGINEER, on the photography of models. After reading these, a half-plate camera was purchased for a few pounds, and, after a brief lecture by the vendor, it was turned on to the subject with mixed feelings of hope and despondency. Advice on development came from a keen photographic friend, together with gift bottles of developing and fixing solutions. The outcome might not impress an expert, but the result may be considered good enough to encourage another novice to try his hand at a fresh occupation.

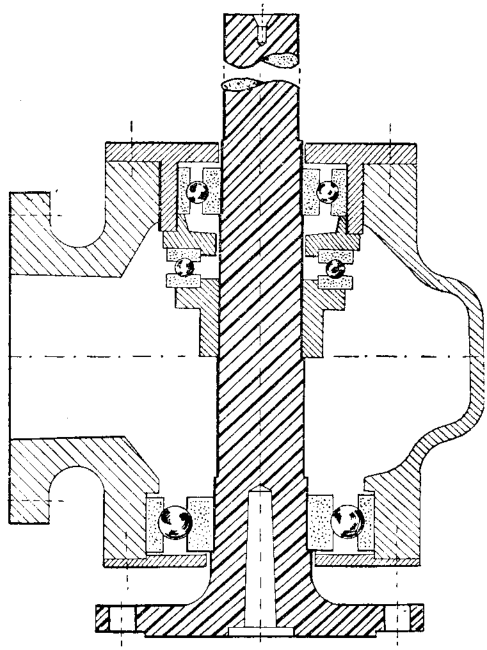


*Fig. 5. Sectional elevation of milling-head*

# For the Bookshelf

**Railway Motive Power,** by Harry Webster, B.Sc., M.I.Loco.E. (London: Hutchinson's Scientific and Technical Publications.) 311 pages, size $5\frac{1}{2}$ in. by $8\frac{1}{2}$ in. Illustrated. Price 30s. net.

This book, which is in three sections, is an excellent general survey of the whole subject of railway motive power and is aptly described by the publishers as "a picture of the developments that have taken place in the design and construction of railway motive power from Stephenson's *Rocket* of 1829 to the gas-turbine locomotive of 1950." The illustrations are in line and halftone; the several sketches of locomotives are not fully detailed or very precise, but they are reasonably accurate.

After a lengthy introductory chapter discussing the many aspects of the problem of providing motive power to meet the requirements of railway traffic, there follows an equally lengthy chapter dealing with the handling and performance of different kinds and types of locomotives, and this closes Part I of the book.

Part II is devoted to steam motive power, and comprises eleven chapters covering such matters as: early steam locomotives; later developments; outstanding examples; basic principles; factors affecting design; the boiler; the engine; the valve gear; present-day types, at home and abroad, and unusual locomotives.

Part III contains seven chapters and covers the electric, diesel-electric and gas-turbine developments of today. A glossary and an index are included at the end.

The text throughout is written in language that can be readily understood by a very wide circle of readers, but we find the author a little astray in his facts, here and there. For instance, in the description of the 1895 "race" to the North, the L.N.W.R. 2-4-0 engine *Hardwicke* ran her train from Crewe to Carlisle *unassisted,* at an average speed of 67.2 m.p.h. and was not piloted by any engine; the average speed achieved by the G.W.R. engine *Tregenna Castle* with the Cheltenham Flyer on June 6th, 1932, was 81.8 m.p.h., not 87.5; the illustration on page 76 cannot be said to depict a Johnson single of 1887; the Stroudley 0-4-2 engine preserved at York is the *first* of the class, No. 214, *Gladstone,* not 172; the latter engine was the last of the class and was withdrawn some seven years after *Gladstone* retired; in the description of the Metropolitan-Vickers gas-turbine locomotive, we are informed that its overall length is 66 ft. 8 in. and its wheelbase is 83 ft., which is impossible. These slips apart, we can recommend the book to all who desire to acquaint themselves with the groundwork of modern locomotive developments; but we note with some curiosity the quaint spelling of the names de Glehn and Stumpff.

# Novices' Corner

## Making T-Bolts

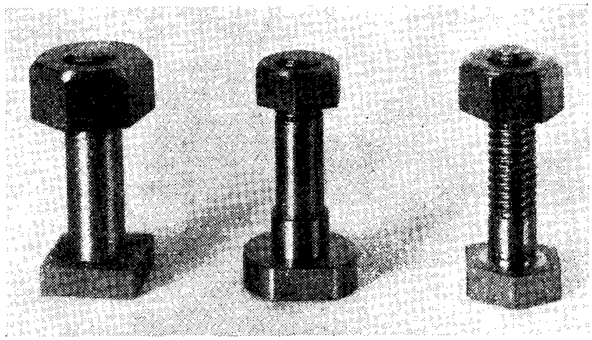


*Fig. 1. Three types of T-bolts. Left—bolt machined from the solid ; Centre—bolt made from round material ; Right—an adapted hexagon-headed bolt*

WHEN securing an attachment such as a machine vice to the lathe saddle, it may be found that the T-bolts belonging to other fittings are too short to serve this purpose, and it then becomes necessary to make a set of special bolts ; moreover, if these bolts are well made they will be more convenient to use and will serve for all time.

Although there are several ways of making T-bolts, those machined from the solid material will usually be found the most satisfactory.

Either square or round mild-steel rod can be used, although there may be a preference for selecting round material, as this is generally stocked in the workshop in larger quantities and is more easily replaced ; in addition, round rod can readily be gripped in the self-centring chuck, and no time is wasted in setting up the square bar in the four-jaw chuck. At the start, the T-slot must be accurately measured and a rough, dimensioned sketch should then be made for reference, as represented in Fig. 2.

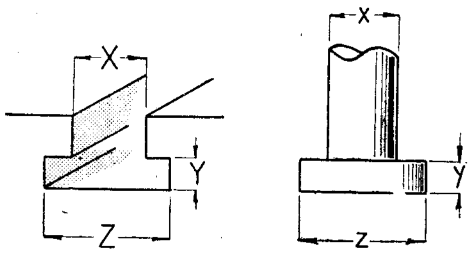



*Fig. 2. Showing the corresponding parts of the T-slot and T-bolt*

The dimension *Y* for the head of the T-bolt can often be measured exactly by using the shank of a drill as a gauge and trying it in the slot ; the dimension *X* may also be gauged in the same way. The easiest way, however, of taking these measurements is to use a taper gauge of the kind illustrated in Fig. 3 ; these gauges are graduated in thousandths of an inch, and the smaller gauge reads from 0.1 in. to 0.5 in. A second sketch can then be made showing the size of the finished T-bolt and taking into account that a working clearance, of at least a few thousandths of an inch, must be allowed at both the head and the shank portions.

### Machining Square Material

To enable the T-bolt to engage in the T-slot in any position and, at the same time, to fit correctly, it is, of course, essential to machine the shank concentric with the head portion. The square rod can be set truly in the four-jaw chuck by applying the test indicator in turn to the four corners, or to the flat faces of the bar as each is set vertically with the aid of a square resting on the lathe bed.

When centring material in this way, the test indicator can be mounted on the pillar of the surface gauge, and the base then rests on the lathe bed with the register pins in contact with the bed shere. An alternative method of centring square material is first to centre a length of round rod of the same diameter in the four-jaw chuck ; two adjacent jaws are now slackened and the same two jaws are finally tightened to grip the square bar. The shank of the T-bolt can be machined

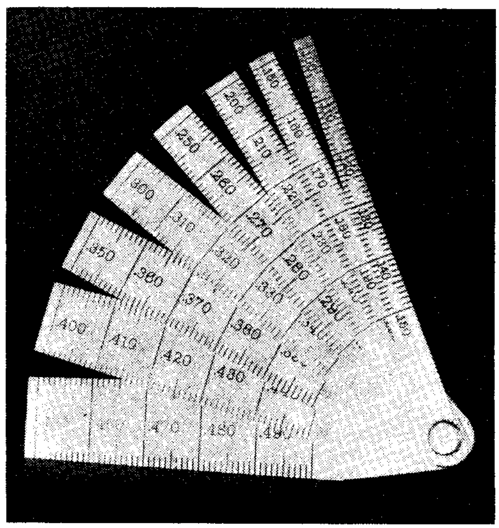


*Fig. 3. The Starrett taper gauge*

with a right-hand knife tool, and is made a few thousandths of an inch less in diameter than the width of the T-slot opening.

This reduction in diameter will also include the portion carrying the thread, but it is an advantage that this should be a little under the nominal diameter, as the die will then cut the thread more easily. The shoulder forming the head should be faced flat so as to bear evenly in the T-slot, and

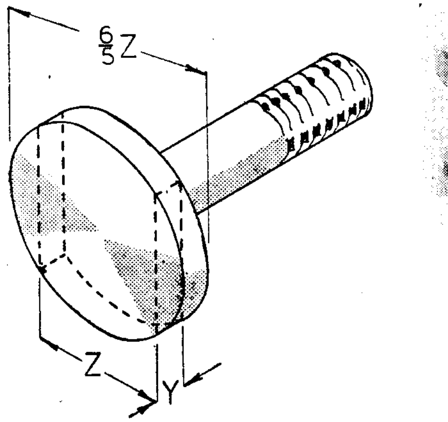



*Fig. 4. Use of round material for making T-bolts*

as the bolt will not be subjected to great strain, there is no need to form the customary radiused curve at the junction of the shank and head portions. The thread can be given a true start with the die mounted in the tailstock dieholder, and sufficient leverage for this purpose can be obtained by holding the lever of the dieholder in one hand and turning the chuck with the other by means of the chuck key. Once the die has got a good hold, the work can be removed from the chuck and the threading completed by gripping the bar in the bench vice and using the ordinary dieholder. The bolt head is next cut to a little longer than the finished length, either with the hacksaw or by parting off the bolt in the lathe. With the shank gripped in the self-centring chuck, the head is then faced to its finished length.

If the head flats have to be filed to fit in the T-slot, care must be taken to remove an equal amount of metal from each face in order to maintain the centring. The filing operation is controlled by first measuring the distance across the flats with the micrometer, and then removing half the surplus material from each flat in turn. If the finished bolt is found to be tight in its slot, tap it gently into place and then carefully file down the pressure marks until the bolt will slide freely for the full length of all the T-slots.

### Using Round Material

Where round material is used for making T-bolts, the diameter of the rod should be about six-fifths of the distance measured across the head flats. The machining is similar to that already described, except that the rod can be gripped in the self-centring chuck. The flats are formed centrally with the shank by again employing the micrometer during the filing operation.

### Adapting a Hexagon-headed Bolt

To save time, a T-bolt can often be made from an ordinary hexagon-headed Whitworth bolt, having a head of standard size and a shank that will fit in the T-slot. After the length of the head has been faced down to fit in the slot, two of the

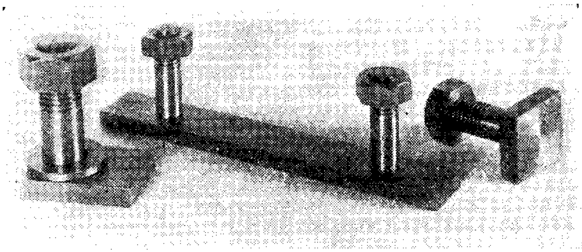


*Fig. 5. Two built-up T-bolts and a bolting strip*

flats may need to be filed equally to enable the bolt to slide freely in the T-slot.

### Built-up T-bolts

To save material, T-bolts are sometimes built up from two separate parts, and, where the head is of the same thickness as the nut fitted, there will be no material loss of strength. The bolt head is first shaped to fit in the T-slot and the part is then drilled centrally and tapped to receive the threaded stud forming the shank. The underside of the head should be lightly countersunk so that the shank can be riveted over after it has been firmly screwed home ; this surface is then again turned or filed flat.

It will sometimes make for more convenient working if a double bolt of the kind illustrated in Fig. 5 is used, but as the studs are set at a fixed distance apart, the fitting may not serve more than one attachment. The base portion is made

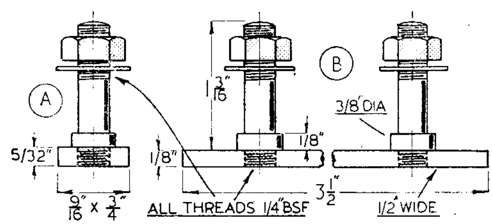



*Fig. 6. Showing construction of a built-up T-bolt—"A"; and a bolting strip—"B"*

in the same way as in the single bolt and, again, this should be an easy sliding fit in all the T-slots.

### Reversed T-bolts

It is not always possible to fit the ordinary form of T-bolt when securing fittings to the lathe saddle, and the bolt is then reversed and takes the form illustrated in Fig. 7.

Here, the part sliding in the T-slot becomes the nut and either a hexagon-headed or a round-

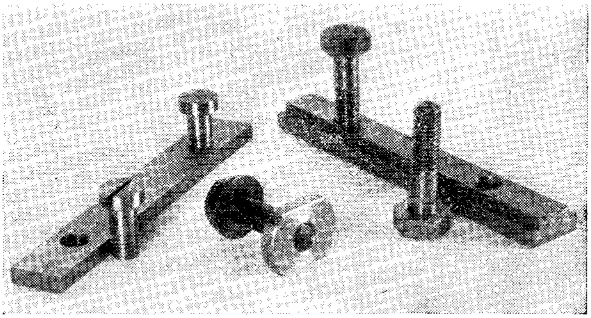


*Fig.* 7. *Reversed form of T-bolt and T-strips*

headed screw is fitted to complete the bolt. As in the previous example, the nut-piece is filed to fit in the T-slot, and the screw is made to suit the particular attachment requiring to be clamped in place on the lathe saddle or elsewhere. This type of bolt is generally used where space is limited,

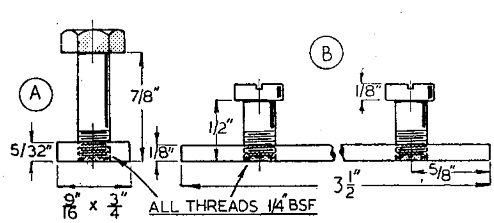



*Fig.* 8. " *A* "—*reversed form of T-bolt* ; " *B* "—*flat strip fitted with screws*

and the head of the screw may have to be accommodated in a countersink or counterbore formed in the attachment.

Where four separate nut-pieces are used, it may not be found easy to engage the screws, but this difficulty can be partly overcome by substituting long strips having a threaded hole at either end. Some T-slots have a rather shallow slot for engaging the head portion of the bolt ; this means that the corresponding nut-piece will not have a very secure hold owing to the shortness of the thread. To obtain a greater length of thread, the nut-piece can be made T-shaped, as illustrated in Fig. 7.

These T-nuts or strips can be machined quite easily in the shaping machine or by an end-milling operation in the lathe.

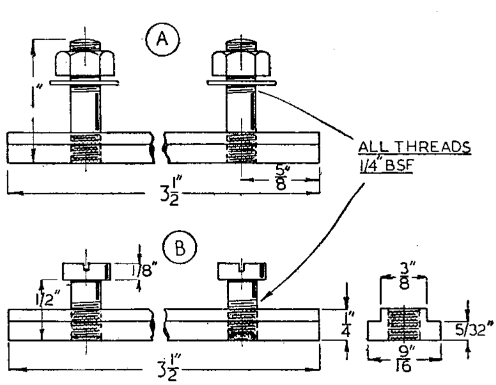



*Fig.* 9. " *A* "—*T-strip fitted with studs* ; " *B* "—*the same fitted with screws*

When, however, the clamping-screws are in this way fitted from above, care must be taken to see that the screws, when fully tightened, keep ust clear of the base of the T-slots.

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# The Aberdeen Model Engineering Society's Exhibition

Our fourth annual exhibition was very successful. Space was allocated to the Aberdeen Model Yacht Club who exhibited fifteen fine models.

Our own models, which were judged by Dr. West, of Robert Gordon's Technical College, and Mr. R. Cunningham, of the Pre-Apprenticeship School, included a fine " Hielan' Lassie " chassis by N. Watson ; an Easton & Amos Grasshopper engine by A. Gauld ; a model of the clipper ship *Thermopylae* by N. W. Wood, and a " Busy Bee " cycle engine. The *Thermopylae* won the Corporation Bronze Medal for the best model of a locally-built prototype.

Lord Provost Reid had very kindly agreed to present the prizes, and in his speech, he made the very welcome statement that if we were to approach the Town Council for a piece of land for a railway track, he did not think there would be much difficulty, and he would fully support the idea. That, together with the fact that between three and four thousand of the public paid for admission, has considerably brightened our outlook.

Hon. Secretary : A. B. Scorgie, 27, Mount Street, Aberdeen.

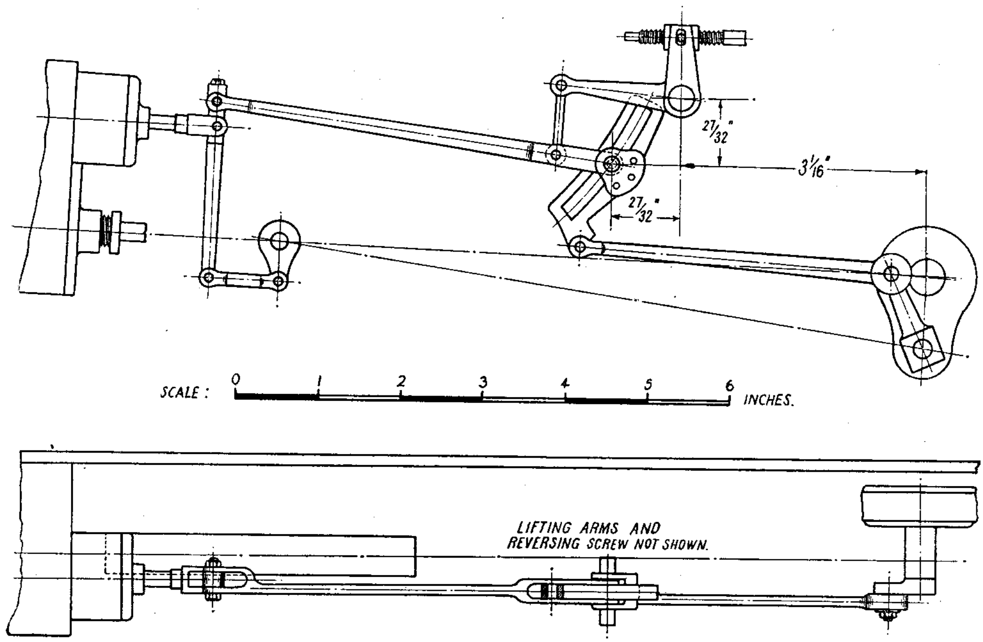
# "Britannia" in $3\frac{1}{2}$-in. Gauge

## by "L.B.S.C."

### Details of the Valve-Gear

BEFORE going into details of valve gear for the little *Britannia*, there are a few observations I would like to make on valve gears in general, and *Britannia's* in particular, for the benefit of uninitiated and other interested readers. Just as the cylinders of a steam locomotive constitute its heart, and the boiler its lungs, so the valve gear is its "nervous system"; and if that isn't "all right," the engine cannot help being "all wrong." Nothing on earth will make it do the job in the manner usually observed among efficient locomotives. Students of locomotive history don't need any reminder that certain engines, good-lookers, well proportioned, and apparently near-perfect in other respects, have been absolutely and completely "mucked up," as the kiddies would say, by a poorly-designed valve gear. Same applies in small practice; it was the wretched valve gears, of earlier days, that gave rise to the idea that an outsize boiler was absolutely essential to any engine expected to pull even a very moderate load continuously. Old *Ayesha* put the kybosh on that! I've already recorded her latest exploit; and as the old girl is just behind me as I write these words, I can imagine her looking over my shoulder and laughing.

Valve gears are not the complicated boxes of tricks that some folk make them out to be; bad grammar, but gospel truth! All a good valve gear is required to do, is to admit steam to the cylinder, cut it off again, and then exhaust it, in the way best suited to give maximum power and speed for the smallest amount of steam consumed; and the simplest arrangement of rods and links, that will fulfil this requirement, will be the most serviceable gear. The less pins and joints you have, the less there is to wear, and cause bad valve events, with consequent waste of steam. When scheming out the valve gear for a little engine, there is one factor to be considered that doesn't need taking into account in full-size practice, viz. the whole doings needs to be robust enough to stand up to the job, without looking clumsy. A "scale" reproduction of a full-sized valve gear would make the engine look fine in a glass case in the Science Museum, but would be useless for hard service on the average back-garden railway, especially on a straight line, entailing constant starting and stopping. To illustrate the fact that a valve gear can be light and neat, yet strong, I have drawn out the valve gear for the little *Britannia*, "naked and unashamed," in a manner of speaking, leaving out brackets and other accessories, just showing the actual components.




*Elevation and plan of valve-gear*

It also shows how the parts are assembled and erected; it would be a fat lot of good giving an elaborate description of how to make up various bits and pieces, without illustrating the way they are put together!

In many of the locomotives described in these notes, I have had very nearly to redesign the valve gear to suit the small size of the engine; but in the case of *Britannia* this was not necessary. The valve gear and setting on the full-sized engines is the nearest approach to my own pet ideas that I have yet happened across; and as there is no harm in stating now that Mr. Riddles not only sent me the preliminary drawings of the proposed "Class 7" but a beautifully-executed artist's impression of the finished job, long before the first of the series was put in hand, I had a quarter-full-size detail drawing of the cylinders and valve gear from which to get out the $3\frac{1}{2}$-in. gauge edition. I settled all my dimensions long since; but as I need no drawings for my own use, it was only last week (time of writing) that I made the reproduced drawings for the benefit of the good folk who are building the little edition. Incidentally, one of my few personal friends, commenting on the similarity referred to, said that it explained the reason why the big engines were twisting the wheels off the axles!

### A Shock for "Scale" Merchants

I must confess to some unholy chuckling when making the drawings. You've probably all met the "scale-at-any-cost" merchant who is never tired of laying down the law on his pet obsession, and repeatedly insists that anything and everything he makes, is absolutely "to scale." Wouldn't dream of anything else! Well, I guess he would not only dream, but have a few bad nightmares, and probably finish up with a single ticket to the loonies' home, otherwise the nuthouse, if he attempted to "scale" the full-size drawings I have here. For example, the calculated distance between the centre-lines of reverse shaft and link trunnion, is—hold your breath—13.4305 in., and the former is 13.4525 in. above the latter; whilst the distance from the centre of reverse shaft to centre of driving axle, is given as 49.582 in. *These measurements are for the full-sized engine*! Supposing he is "scaling down" to gauge "O"; by the time he is through there will be a row of decimals stretching from Euston to the end of Wigan Pier, and how on earth he would work to them, goodness only knows!

It is hardly necessary to add that such minute dimensions are not included in the actual job, though there are plenty of thirty-seconds and sixty-fourths. Now 1/32 in. full size becomes approximately 0.002 in. in $3\frac{1}{2}$-in. gauge; and it takes a darned clever and experienced worker to lay out, say, a rod with a couple of holes in it, to these dimensions, and drill and finish the rod correctly. Personally, I don't attempt it, for the simple reason that I find it not necessary; proof of that is the way my own engines do their job, as the few who have seen them at work will readily confirm. Mind you, there is all the difference in the world between a reasonable degree of accuracy, and downright "sloppiness"; not for one moment would I ever condone the latter. There is, however, a medium in all things.

### Brief Specification

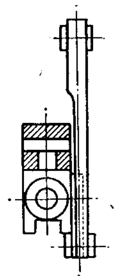
Suppose we take a survey of the whole layout before starting the actual job, and get some idea of what is to be done. In the first place, there isn't any need to copy the valve-spindle guides of the big engine; the long bearing surface inside the steam-chest covers provides ample support for the spindles, without adding to complication. Consequently, a plain fork, or clevis, does for the valve crosshead, and is made with jaws just wide enough to accommodate the combination lever. It screws on to the valve spindle. The combination lever itself is a plain bar, thinned down to clear the crosshead. As you can see by the end view, it clears by a full 1/32 in. If this clearance were made "to scale," you would just about be able to put a piece of paper between crosshead, guide bars, and combination lever; and the slightest sideplay in the latter would cause disaster. To save an offset drop-arm on the crosshead (already described) the two forks on the ends of the union link are offset 1/32 in., which allows the link to hang straight between combination lever and drop arm. The lengths of these links and the lever are exactly proportionate to full size.

The radius rods are ditto, and the fork at the leading end is offset, in the same manner as its full-size relation; thus it lies parallel with the centre-line of motion. The lifting link works in the long fork, just ahead of the expansion link. The latter is made from a single slab of metal, with a kind of lug attached at each side, to carry the trunnion pins. On the original drawings, these trunnions were shown running in plummer-block pattern bearings; but this idea was discarded in favour of a newer arrangement, in which the trunnions run in solid bushes, which are retained in place in the specially-shaped bracket, by circular plates bolted on. When I first saw the retaining plates, I thought they covered Timken or ball-bearings; in fact, the bracket lends itself so readily to the fitting of ball-bearings for the link trunnions, that I am doing this on my own engine, and will give the details, as an alternative later.

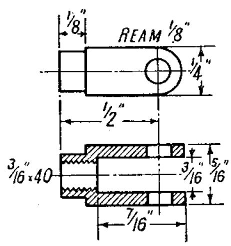
The upper part of the expansion link bracket carries the bearing for the reversing shaft; and a further extension above this, on the left-hand bracket, carries the reversing screw, which instead of being in the usual place in the cab, actuates the reversing arm direct. On the big engine, it is carried in two roller bearings, and actuated by a regular automobile cardan-shaft with a Hardy-Spicer universal joint at each end; the front one is connected to the reversing screw, and the back one to the short shaft in the cab. The latter is operated, through bevel gearing, by a wheel set parallel with the centre-line of the engine; so that, as Mr. Cox said when describing the gear at the Institution of Locomotive Engineers, the driver turns the wheel in the same way that his wife turns the domestic wringer.

On the little engine, we shall use a similar arrangement; but the ends of the screw will run in plain bearings of the type I usually specify for cab reversing screws. The rotating shaft will have two weeny simple home-made universal joints in it. The pins on the reversing nut will work in slotted holes in the reverse arm, as shown. The lifting arms are double, the expansion link

working between them; a neat arrangement allowing a direct lift over the link without any chance of fouling. The expansion link is rocked by the usual eccentric rod, with an offset forked end, to keep the rod parallel with the centre-line of the engine. On the full-sized job, the bearing at the rear end, which works on the return crankpin, has a ball-race in it. On our little sister, we can follow suit, if the necessary ball-bearing is available; or substitute a plain bush, made to the size of the bearing. There is nothing special about the return crank; it has a square boss, and when correctly adjusted, two small bolts will be put through the thickness of this, preventing



*Showing clearance between crosshead and combination lever*

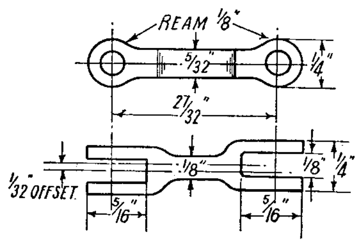



*Valve fork or crosshead*

it both turning or coming off. That is about all there is to it, so now we can go ahead.

**Lap-and-lead Movement**

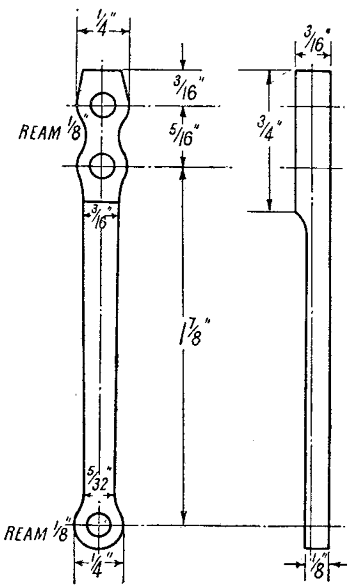
The first item will be a couple of valve forks or crossheads, which can be made from $\frac{1}{4}$ in. $\times$ $\frac{5}{16}$ in. mild-steel. If you use a piece long enough to allow for clamping under the slide-rest tool holder, each end can be slotted in turn, by running up to a $\frac{3}{16}$ in. saw-type milling cutter on a stub mandrel held in the three-jaw. Quite a small cutter suffices for doing this kind of job; I still use some that I bought "surplus" after the Kaiser's war, for a few pence each. They are easily home-made, as I have already described




*Union link*

more than once. It is a good wheeze to drill the cross-holes before slotting, which I usually do; but if drilled afterwards, put a bit of $\frac{3}{16}$ in. flat rod between the jaws of the fork, to prevent the drill wandering, when it reaches the farther side. Saw or part off the slotted ends, a full $\frac{1}{2}$ in. from the centre of hole. Chuck truly in four-jaw, plain side outwards; turn the boss to given length, centre, drill 5/32 in. and tap $\frac{3}{16}$ in. $\times$ 40. Face off to length, then remove from chuck, ream the eyes, and round off the ends, preferably using a filing jig, as described in the *Tich* notes.

Each combination lever requires a piece of $\frac{1}{4}$ in. $\times$ $\frac{3}{16}$ in. mild-steel rod, a full $2\frac{1}{2}$ in. long. The easiest way to recess the part that clears the guide bars, is by doing both, at one fell swoop, with a milling cutter. My own method is to clamp the piece of steel, which should be a little over 5 in. long, to a piece of stout bar, say about 1 in. square. This is held in the machine-vice on the table of my milling machine, and traversed under a small slabbing cutter on the arbor, the $\frac{1}{16}$ in. cut being taken out at a single traverse of the table, just the same as when milling a coupling-rod. The piece is then sawn in two, drilled and reamed as per drawing, and the ends rounded off, the




*Combination lever*

levers being filed to the shape shown. Failing either a milling machine, or a milling attachment for the lathe, the humble file will easily do the whole lot, if used judiciously. On the full-sized engine, the holes are bronze-bushed; builders of the little one can follow suit, if they so desire, drilling the holes No. 15, and turning the bushes from $\frac{3}{16}$ in. round bronze rod. Alternatively, ream the holes in the lever with a $\frac{1}{8}$ in. parallel reamer, and case-harden them in the manner fully described in the *Tich* serial.

The union links are made from $\frac{1}{4}$ in. $\times$ $\frac{5}{16}$ in. mild-steel, the slots being formed as mentioned above. Drill the holes first, with No. 32 drill, at 27/32 in. centres. Note that the centres of the forked ends are offset 1/32 in., which obviates any setting-over of either the crosshead drop-arm or the combination lever, yet gives the desirable straight drive. After drilling and slotting, the links are filed to the shape shown, and the holes reamed, and the ends nicely rounded off. Don't erect the parts yet, as we will do the whole lot together.

# Metal Polishing in the Home Workshop

## by A. R. Turpin

SOME three years ago I decided I would take up silversmith's work as another hobby, and if I was going to make any show, it would be necessary for me to know a lot more about the art of metal polishing than I knew then. But having obtained a couple of books from the library on the subject, I nearly abandoned all idea of a successful amateur's polishing shop when I read, " h.p. required two ; periphery speeds 5,000 to 15,000 ft./min. ! "


*A leather-covered bob*

However, I decided to read on and find out if it was not possible to reduce these figures somewhat, provided I was content to accept longer man-hours, and perhaps a slightly duller polish. At that time, like most other model engineers, the only equipment I possessed was a screwed spike on the other end of my grinding wheel spindle, driven by a ¼ h.p. motor by means of which I was able to obtain some sort of polish on brass sheet ; but I was quite unable to polish out deep scratches, or hammer marks. So something had to be done, and I read on.

The actual process of polishing consists first of grinding the article with repeatedly finer grades of abrasive, the abrasive having been glued to the periphery of a semi-resilient wheel ; secondly, continuing the polishing process using softer wheels to which has been applied a composition made by mixing very fine abrasives with greases and waxes. During the first part of the process, metal is actually removed from the article, but during the second part the heat and pressure causes the metal to flow from the hills of the scratches into the valleys.

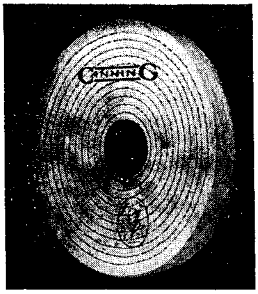
This skin is called the Bielby layer.

Before I proceed further describing the actual process of polishing in detail, I had better set out a short glossary of terms used in this article.

*Bob.* A semi-resilient polishing wheel, either constructed wholly of felt, or partly a wood centre, the periphery of which is covered with a strip of felt or leather.

*Buffing.* Usually applied to the final stages of polishing.

*Colouring.* The application of a very mild abrasive for the final polishing operation to bring up the true colour of the metal and impart a high finish.




*A stitched cotton mop*

*Linisher.* A machine employing an endless belt of abrasive material.

*Mop.* A resilient polishing wheel manufactured from discs of cotton fabric, loose except for the centre, or sewn together with spiral or concentric stitching. Usually used for the buffing and finishing operations.

*Scratch brush.* A rotary wire brush.

*Scurfing.* Usually applied to the grinding operation with bob or mop using " glued-on " abrasive.

The chief abrasive materials used in polishing in a small workshop can be limited to the following :

For scurfing : emery and Aloxite in the grades 80, 120 and 160 mesh.

For buffing : composition sticks of tripoli, crocus and rouge.

For colouring : rouge and Vienna lime.

A number of 10 in. × 1 in. and 6 in. × 1 in. bobs and loose leaf mops.

However, the prices of felt bobs have risen so greatly during the last year that the occasional user may consider the less efficient alternative, the stitched calico mop, but the polisher will have to look out for rounded corners.

To dress a bob or mop with abrasive, first size the wheel using a weak glue for this purpose, and brushing it well into the surface, allow to

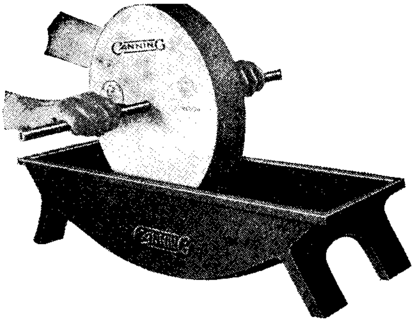
dry and then true by running on the spindle whilst rubbing a coarse brick or pumice stone against it.

The bob or mop should now be heated on the periphery—this can best be done by revolving it on a hot plate—and it is then liberally coated


*A soft unbleached "Brown" calico mop, and green chrome composition. For finishing stainless-steel*

with bobbing glue. The strength of the glue should vary with the fineness of the grit ; one part of glue to two parts of water by weight for, say, 60 grit and three parts of water for 180 grit, intermediate sizes diluted *pro rata*.

Meanwhile, the abrasive should also be heated, and the bob immediately rolled in it. This is easily carried out if a simple trough is made by nailing two battens of wood to the bench top, the width of the bob, or mop, apart. The warm abrasive is poured between the battens, and the bob rolled along between them ; the advantage of this method is that the abrasive is not spread over the bench, and in the case of mops, the leaves are prevented opening and allowing the abrasive to get between them. With the larger size bobs



*Rolling a bob in warmed emery*

it will be necessary to take two bites at it, unless the trough is very long, then press the abrasive well into the glue.

The bob is now set aside for 24 hours to dry.

When it is, a mop that has to be dressed and is required to retain some of its flexibility for contour polishing, the hard rim of glue should be broken up by striking it with a metal bar.

Always apply a newly coated bob to a scrap piece of metal ; this helps to bed the abrasive down evenly, and at the same time gives a warning if it has been contaminated with the wrong size grit.

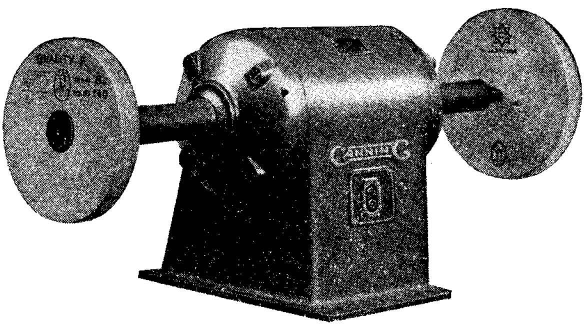
When the bob ceases to cut, it can be recoated on top of the old dressing unless that dressing is very uneven, in which case it should be removed. To do this, wrap a damp cloth round the periphery of the bob or mop, and let it remain for three or four hours until the glue has softened ; it is then revolved on the spindle and scraped with a piece of hacksaw blade.

There are countless types and sizes of bobs and mops that can be purchased, but the four most useful types are as follows :—

Solid felt bobs or leather and felt-covered wheels with wood centres for scurfing and the early stages of buffing ; stitched mops for scurfing contoured and irregularly shaped articles ; loose leaf mops for buffing, and swansdown mops for finishing. The last, by the way, are not real swansdown but a very soft cotton.

A useful size is 6 in. dia. × 1 in. thick for scurfing and 10 in. × 1 in. for buffing on spindles running at 2,900 r.p.m.

To dress a mop for buffing, it is mounted on the polishing head, and rotated at polishing speed, and the stick of compo is then pressed against it



*Bench mounting polishing motor*

for the friction to cause sufficient heat to melt the waxes, which will then adhere to the mop. A little and often should be the rule. By the way, it is surprising how stiff and hard even the most pliable mop appears to become under the influence of centrifugal force.

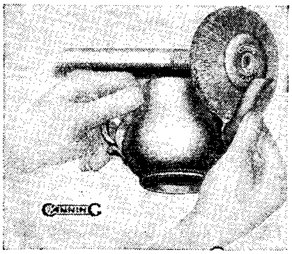
The process of polishing is best described by taking a practical example, such as the way a cast brass door handle would be commercially polished in small quantities.

The casting, if necessary, should be cleaned up with a solid grinding wheel ; it should then be scurfed all over with a bob dressed with emery No. 90 followed with No. 120. This is followed with a mop using Tripoli compo, and coloured with Vienna lime compo on a swansdown mop.

The scurfing operations should be carried out at 5/6,000 ft./min. and the mopping or buffing, and finishing or colouring, at 7/8,000 ft./min. Each operation should be carried out at right-angles to the last—this is not only more efficient,

but also makes it easier to see when the scratches from the previous abrasive have been completely removed.

For other metals the operation and material may be somewhat different, and a guide to the more important is as follows :—



*Dry scratchbrushing*

*Cast-iron and steel.* Scurf as for brass but finish for high polish with crocus compo.

*Stainless-steel.* Scurf with Aloxite No. 120 or coarser if necessary, then grease bob with 120 emery, followed by leather wheel with flour emery. Mop with hard mop and alumina compo, and finish with soft cotton mop and chromic oxide. Speeds should be 20 per cent. higher than for brass.

*Aluminium Castings.* Scurf with bob dressed with No. 60 emery, follow with No. 80 and 120, used at right-angles to each other. The bobs should be lubricated with a touch of bobbing grease to stop dragging of the surface. Mop with loose leaf mop and soft Tripoli compo. Finish with swansdown mop and Vienna lime. The speeds may be 20 per cent. slower than for brass.

*Copper.* As for brass, but may be finished with rouge compo.

*Silver plate.* Mop with swansdown mop and rouge compo, wash in a detergent, and finish with a very soft mop to which a paste of rouge powder and methylated spirit is applied with stick. If the plate is at all rough, scratch brush first with a fine crimped nickel-silver wire wheel.

It will be obvious that it would be impossible to polish all articles with ordinary bobs and mops, and specially shaped ones are often used such as for polishing between the splines of forks ; or small fingers to get round handles of jugs, etc.

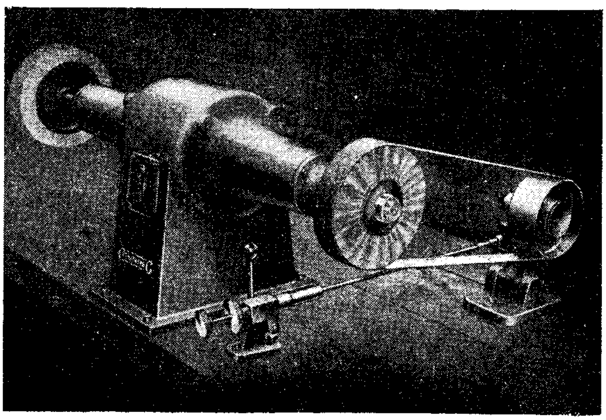
Even then, there may be a considerable amount of work that must be carried out by hand in order to polish in the awkward places.

To do this, tool marks can first be removed with Water of Ayr stones, or by abrasives mixed with grease and rubbed on with pointed and shaped sticks. Polishing thread is used to polish inside of holes. Embossed and figured work can be polished with bristle wheels, the abrasive being applied to the wheel in the same way as to the mops when using compo.

Now the owner of a small workshop will look wistfully at the screwed spindle on his " grinder-come-polishing " head, and wonder if all this equipment is really necessary ; the immediate answer is " No " if you have not to pay shareholders dividends. Whether you spend two or ten minutes polishing up a boiler dome is of no great importance to you, and anyway, the only metal you are likely to want to polish with a real mirror finish will be brass. So we can concentrate on that material, and if we are careful when fabricating the article, we shall need only one emery bob of No. 120 mesh ; even quite deep scratches can be removed with this grade, provided you can spare the time.

Although the bobs are more efficient, in order to save money, we can use stitched calico mops for scurfing. For buffing we need a loose leaf mop and a stick of Tripoli compo, and in most cases the polish obtained with this will be sufficiently brilliant. So really all we need, at least for a start, is two mops. The polishing spindle should be somewhat more robust than those normally found in the amateur workshop ; it should be at least $\frac{3}{4}$ in. dia. and preferably project at least 12 in. A $\frac{1}{2}$ h.p. 2,900 r.p.m. motor is about the minimum power that can be used efficiently, and with this spindle speed we can use a 6 in. mop for scurfing, giving a surface speed of 4,550 ft./min., and for buffing a 10 in. dia. giving 7,600 ft./min.

When polishing, the article must be kept on the move the whole time, otherwise a distorted finish will result, and on no account should the mop be allowed to dwell in one spot to remove a deep scratch. When polishing with a $\frac{1}{2}$ h.p.



*A bench-type idler backstand*

motor, it will be difficult to apply too much pressure before slowing the motor, except when finishing, when a comparatively small pressure is all that is required.

It is fatal to try to polish out deep pits or scratches by buffing, because you will find that they turn themselves into what is known as " tailheads " or " spearheads," depending on whether the pits have grown one, or two tails.

All deep scratches and pits must be removed during the scurfing operation.

NOTE.—One means of overcoming the need for a number of bobs coated with different grades of emery, is to use a " back stand " idler. This consists of an idler pulley mounted on a pillar directly behind the polishing bob; a Linisher band is then used instead of coating the bob, the band running round the bob, and back over the idler pulley; it then takes but a few seconds to remove one grade of band and replace by another; further, there is no wear on the expensive bob. Some difficulty may be experienced in getting a narrow band, but this may be overcome by cutting one of standard length.

Great care should be taken that the bob or mop does not snatch at the trailing edge of the work, if it does it will most likely snatch it from your hand and smash it on the floor, or even whirl it round the mop and smash it into your face—and this can be really dangerous. Any other machine tools in the workshop should be covered up during the polishing process to prevent the abrasives getting into the works with disastrous results. It is also as well to cover yourself up, especially your hair, for the same reason.

To mechanically polish plastics, great care must be taken, because it is extremely easy to burn it, or polish large chunks out of it before you know where you are.

The safest way is to start by hand and get rid of all tool marks by using finer and finer grades of glass paper, follow this with pumice compo on a canvas mop, and finish with a fine white polishing compo on a swansdown mop. But do be careful and try things out on some scrap first. At a push, ordinary metal polish, followed by silver polish will do quite a good job.

Finally, when in doubt, ask, and the people to ask are those experts who manufacture the hundreds of different materials to do the job, they have a reputation at stake and they will not let you down. Two of the foremost people in this line are W. Canning & Co. Ltd., Great Hampton Street, Birmingham, 18, and St. Johns Street, Clerkenwell, London, E.C.1., and Grauer & Weil Ltd., 3 & 4, Hardwick Street, Clerkenwell, E.C.1.

# The Model Power Boat Association

At the A.G.M. held recently, several matters of interest were discussed.

**Finance.**—The balance sheet was presented and showed that the funds of the Association are being maintained in spite of rising costs. Copies of the balance sheet may be obtained on application by club secretaries.

**Regatta Organisation.**—The following recommendations to assist regatta organisation were made by the meeting. These are not rules, but should be applied where appropriate.

*Speed Events.*—For each run, competitors should be allowed three minutes from first pull of starting cord to start the boat.

*Straight Events.*—Steam-driven boats should be given precedence in order of running.

In steering events boats should be returned on a triangular course where layout of lake permits.

**Radio Controlled Boats.**—Clubs are asked if they are interested, particularly concerning radio control of boats powered by steam or i.c. engines; also, the possibility of special events for these craft.

**Record Claims.**—Alterations were made to Competition Rule 13. All speed records must, in future, be made by electrical timing equipment, whether at regattas or not.

Records made at a regatta held under the auspices of the M.P.B.A. need not be claimed in future.

**Election of Officers.**—The following officers were elected :—

President : E. W. Vanner ; Vice-Presidents : F. J. Pierson, K. Williams, F. Bontor ; Chairman : E. T. Westbury ; Vice Chairman : J. B. Skingley ; Hon. Secretary : J. H. Benson ; Hon. Asst. Secretary : A. A. Rayman ; Auditors : L. Pinder, R. Cluse.

Provincial clubs are reminded that they may nominate a member of a London club to represent them at committees if they are unable to send a delegate. The hon. secretary will forward names of London members willing to do this.

**Regattas.**—The following fixture list was arranged at the meeting :—

| | |
|---|---|
| May 4th .. .. | S.E. Association (straight boats only) |
| ,, 18th .. .. | South London (straight boats only) |
| ,, 25th .. .. | Victoria |
| ,, 31st (Whit. Sat.) | Welling (straight boats only) |
| June 2nd (Whit. Mon.) | Bournville |
| ,, 8th .. .. | International |
| ,, 15th .. .. | Blackheath |
| ,, 22nd .. .. | St. Albans and N. London |
| ,, 29th .. .. | Orpington |
| July 6th .. .. | Wicksteed |
| ,, 13th .. .. | Derby |
| ,, 20th .. .. | Bedford |
| ,, 27th .. .. | Hispano Suiza |
| August 10th .. .. | South London (Pole boats) |
| ,, 17th .. .. | Southampton |
| ,, 31st .. .. | Grand |
| September 14th .. | Kingsmere |
| ,, 21st .. | Southend |

Will club secretaries wishing to make additions to this list, please let Mr. J. H. Benson have the dates as soon as possible.

Hon. Secretary : J. H. BENSON, 25, St. Johns Road, Sidcup, Kent. Tel. : Footscray 7428.

# Cone Development by Triangulation

## by Andrew Smith, A.M.I.E.D.

WHILST the method of forming the development of the blank to produce a plain or truncated cone is known to most mechanics, difficulties are frequently encountered in circumstances where the cone is not a right cone but is instead of the form known as an oblique cone (see Fig. 1).

In the case of the right cone, the method of producing the development is shown in Fig. 2, where with $O$ as centre and $OB$, the slant height of the cone, as radius, the arc $PQ$ is drawn. The curved length $PQ$ is, of course, equal to the circumference of the cone base, and may be obtained by stepping off from a subdivided plan view, or by calculating the circumference, that is 3.1416 $AB$. In practice the angle $POQ$ is often computed. Taking as an example a cone having a base 10 in. diameter with a slant height of 15 in.

$$\text{Angle } POQ = \frac{10 \times \pi \times 360^\circ}{2 \times \pi \times 15} = 120^\circ$$

or

$$\text{Angle } POQ = \frac{\textit{Diameter} \times 180^\circ}{\textit{Slant height}} = 120^\circ$$

The development of an oblique cone cannot, however, be obtained in this manner. With shapes of this type the blank is obtained by assuming that the article is made up from a number of

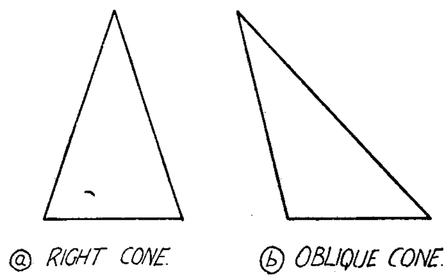



*Fig.* 1.

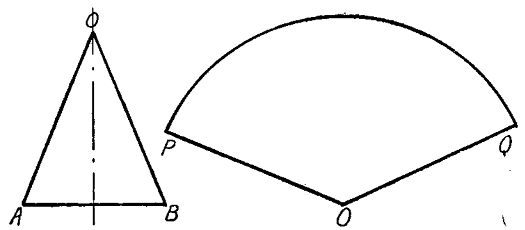



*Fig.* 2. *Development of right cone*

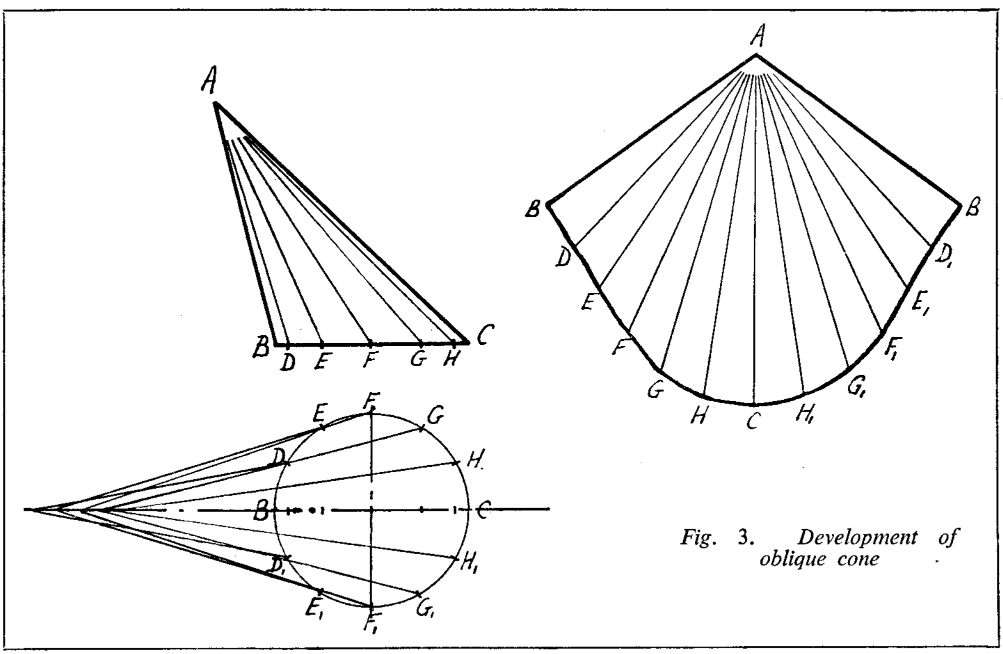



*Fig.* 3. *Development of oblique cone*

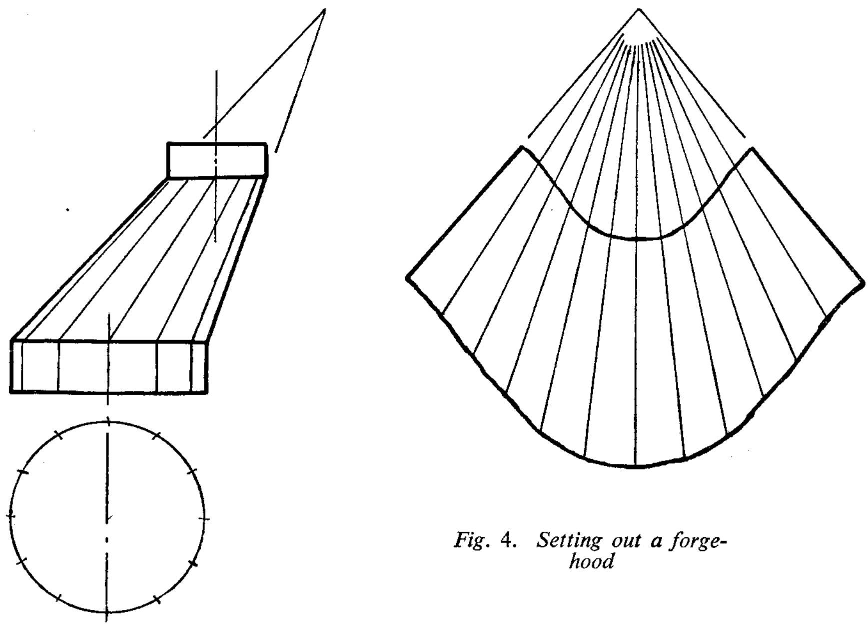


*Fig. 4. Setting out a forge-hood*

triangular strips having a short base length.

The first stage in development by triangulation is to draw the front elevation so that the true lengths of the edges *AB* and *AC* may be ascertained (Fig. 3). Draw the plan of the base, that is a circle, and divide the perimeter into an even number of arcs of equal lengths. Project the division points up to the elevation base *BC* intersecting at *D*, *E*, etc., also downwards to cut the horizontal centre-line of the plan. Now the lines *DA*, *EA*, etc., on the elevation for the perpendicular heights form triangles, the sides of which conform to the outline of the cone. The bases of the triangles are equal to the distances *DD*, *EE*, etc., on the plan.

From the intersection on the centre-line of the lines *EE*, etc., on the plan, mark off the respective lengths of *DA*, *EA*, as given on the elevation. Complete each triangle as shown, the hypotenuse of which gives the true length at the stated position.

With the true lengths at each position known, draw a vertical line *AC* equal in length to *AC* on the elevation. On either side mark off the distance equal to a division on the plan. With *AC* as centre, mark off *H* and $H_1$ equal to the true length taken from the true-length diagram. Continue this for each position, finally, taking the true length of *AC* from the elevation. Now draw a line through the points of intersection; this gives the blank shape enclosed by the lines *ABCBA*.

Finally, Fig. 4 illustrates an example of this method put to use recently by the writer, in setting out a forge-hood to meet an offset flue pipe.

The first stage, after completing the elevation of the required connection, was to project the cone upwards to find its apex. The main outline of the development was then obtained as for an oblique cone of base equal to the large diameter and height equal to the distance from base to apex. The truncated portion was then determined in a similar way, working from a base equal to the diameter of the small opening on the connection.

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# Socket-head Screws

Mr. H. Glyn Jones writes :—" Mr. Herridge's article on this subject is very informative, but I do wish that somebody would now supply a little information which would be of even more benefit to model engineers, and that is the name of any supplier who is willing to sell these screws in small quantities.

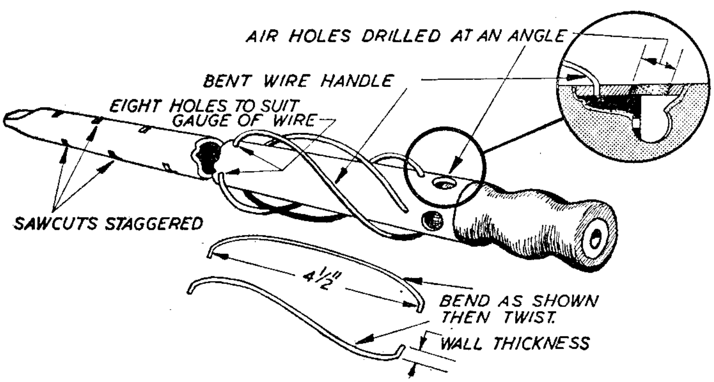
" It is easy enough to buy the ordinary bolts or screws, but I have not yet found any firm which carries a range of socket screws, who is willing to break the standard packings. As these standard packings seem to vary from 1,000s in the smaller sizes through grosses down to quarter grosses in the larger sizes, it becomes quite impracticable, as a rule, for a model engineer to use the screws."

# PRACTICAL LETTERS

## Gas Poker Modifications

Dear Sir,—I have completed the gas poker described by Mr. A. Smith in your Christmas number (December 6th, 1951), and found that some modification was necessary to obtain a hot blue flame. First, the total cross-sectional area of the air holes needs to be considerably greater than would be obtained from six $\frac{1}{8}$ in. dia. holes. A further aid to the maximum air flow would be to drill the air holes at an angle to avoid sharp corners. A fine jet is fitted at the inlet and extends to just past the air holes; this obviates any danger of gas seeping through the air holes, as I found to be the case before the jet was fitted.

Now for the handle. Mr. Smith stated that as a "one off" job, the making of a jig for the manufacture of a spiral wire handle would hardly be worthwhile. I quite agree, but on the other hand a solid finned handle is not the best medium for heat dissipation, especially as the poker may inadvertently be left in the fire long after it has served its purpose.




The method adopted on my own effort is as follows:—

Two rows of No. 37 drill holes, eight in each row, were drilled round the periphery of the tube, the two sets of holes being approx. 4½ in. apart. Next, bend up eight pieces of suitable wire (I used copper-coated M/S welding-rod) to the shape shown, the "legs" at each end not to exceed the wall thickness of the tube wall. The method of assembly is quite simple. Insert one of the legs into one of the holes in the bottom row, then twist the wire sufficiently to allow the other leg into the third hole out of line. (For the sake of clarity, the sketch does not show all eight pieces of wire in position on the poker.) The final twisted effect of the handle is quite pleasing, and, moreover, the handle remains cool although the tube may be almost at red heat.

I trust the above may be of interest to those of your readers who may be contemplating the construction of the gas poker.

The hour or so required for this reaped dividends, in the form of domestic harmony out of all proportion to the time and effort spent.

Yours faithfully,

Hampton. G. W. Trotter.

## Domestic Refrigerators

Dear Sir,—Seeing a letter by "Facitor" on this subject in a recent issue of The Model Engineer, wherein he warns possible buyers of second-hand compressors and other equipment of the troubles they are likely to run into, perhaps my own experience may be of interest.

In March last year I was attracted by advertisements in The Model Engineer of *ex*-Frigidaire and other compressor units, and thought I would like to have a go at building a complete refrigerator for home use.

At that time I had no experience whatever of these things, only a knowledge of the broad principles of operation. I did know that one required in addition to the compressor unit, an expansion valve, evaporator, and thermostat control. I saw the advertiser and picked out a small twin-piston compressor (the smallest unit available). This consisted of the compressor mounted on base (no motor), condenser and liquid receiver with drier attached.

I did not discover what the drier really was until much later!

With the unit I obtained a Frigidaire thermostat control, an expansion valve with sundry bits of pipe attached, and an evaporator which I could see from local shop windows was a Frigidaire production.

There was the essential material, and the first step was to totally dismantle the compressor unit. Bearing, pistons and cylinder walls were in good condition, but cylinder-head and valves were somewhat corroded. In passing, "Facitor's" chemistry is not so good either, as $SO_2$ and water ($H_2O$) will produce $H_2SO_3$ which is sulphurous acid and not sulphuric acid. Granted that sulphurous is also a corrosive acid, but not so violent as sulphuric.

Having cleaned up the corroded parts, the compressor was reassembled with new gaskets and an enquiry was sent to the Vacuum Oil Co. for the correct brand of oil to use with methyl chloride as the refrigerant. Next, the drier was removed from the receiver and opened up. It was found to contain a tightly packed mass of a brown powdery substance, saturated in oil, as were the fine gauze filters at each end of the drier. The whole lot was thoroughly cleaned out and left till I found out what to put in it.

By this time I was anxious to see if it would work, so a suitable motor was obtained and the lot assembled in the workshop with expansion valve, evaporator, etc., connected up with copper tubing. A small quantity of methyl chloride was introduced into the system *via* the suction valve, and a trial run was made. It started operating immediately and I was able to observe that the thermostat control was in working order,

but after half an hour or so it ceased work and on opening up the expansion valve I found the needle valve frozen to its seating!

However, I had seen enough to know that the assembly would work, and so a start was made on the cabinet. By the time this was completed, working week-ends only, I had been recommended to put activated alumina in the drier, and everything was ready for the final assembly of the components in their appointed places. During first tests of the completed refrigerator, there were only two troubles, moisture in the system, and leaks. The first was cured by frequent removal of the microscopic portion of ice on the needle of the expansion valve and occasional renewal of the contents of the drier.

I had learned by this time how to purge the system of air after disconnecting any item, and after a week of daily tests (holiday week) I had no further trouble from moisture.

The second was rather more trouble, and I decided to invest in a leak detector lamp, and found it well worth while. Small leaks were discovered in places I should never have thought of, and one was traced to the diaphragm of the expansion valve. I was able to repair this, and the refrigerator was put into service in June.

During these early tests I found that the Frigidaire thermostat control had an enormous range of temperature, and while it would easily maintain around 40 deg. F. for normal use, it is possible to set it to just over 5 deg. F. if wanted.

At the end of September the gas was pumped into the receiver, the valves shut down on it and the whole thing left, as I thought, for the winter months.

However, during the long Christmas holiday it was decided to open up again in order to keep some ice cream for Boxing Day. Everything went without trouble, and the control was set to 10 deg. F. It was finally shut down again, and I have every confidence that next June I shall be able to start it working without doing anything more than opening the valves.

The point of all this is that I am still using the original components purchased for the job, and I think no one should be deterred from attempting to construct a home refrigerator with odd second-hand parts such as I obtained. If troubles appear, these could be satisfactorily dealt with by a model engineer with no more than the exercise of common sense and a little patience.

Yours faithfully,

Wallington. W. GREEN.

### Old Mill Engines

DEAR SIR,—I was interested to read of the Lancashire Mill Engines as described by your contributor E. Bowness in the January 31st issue of THE MODEL ENGINEER, but why speak of them as things of the past when in this town alone, I should think that there are no less than twenty such engines at work today, most of them coming over the 1,500 h.p. mark.

These wonderful pieces of engineering perform their daily task easily, silently and with little or no trouble through breakdowns, due mostly to the care with which they are handled and maintained by their engineers; note, I say engineers, and not engine tenters, as they are mostly called in other parts of the country. Quite a few of these men actually took part in the building of these engines when they were installed.

Getting back to the engines, however, they are everything that Mr. Bowness claims for them —plus. Among the ones I have been fortunate enough to inspect are an 1,800 h.p. marine type, triple expansion engine (Marlborough Mills Failsworth); a four-cylinder compound beam engine, 1,400 h.p., with a 60-ton flywheel (Iris Mill, Oldham); and an engine very similar to the one your correspondent describes, which alas is no more, but whose 2-h.p. cylinders were named Ruby and Diamond (Gem Mill, Chadderton).

The boiler layout is fairly standard with all these engines, with four Lancashire boilers 30 ft. long × 8 ft. diameter, one of them usually dry for cleaning, and the pressure is in the region of 160 lb. per sq. in.

I agree that they make marvellous material for model engineers, and I have yet to see a model which fully represents a Lancashire Mill Engine; perhaps the reason may be, as "L.B.S.C." says: "life is too short."

Yours faithfully,

Oldham. A. RAYNOR.

### Cornish Beam Engine

DEAR SIR,—As a reader of THE MODEL ENGINEER, I was interested in the cover picture and note in "Smoke Rings" of the old Cornish pumping engine, which appeared in the issue dated January 24th, 1952.

There is another 80 in. working model at the Cornwall Technical College, "Trevenson," Camborne, made by Mr. Cheshire, one of the masters.

This model was exhibited at our exhibition last year. It covers a floor space of 8 ft. × 3 ft., and stands approximately 7 ft. high.

Yours faithfully,

R. F. HARVEY.

*(Assistant Hon. Secretary, Perranporth and District Model Engineering Society.)*

### Risks With Electric Heaters

DEAR SIR,—May I be permitted a line or two to warn novices against employing electric locking rings in the manner described in Novice's Corner of January 17th. I cannot see the point of trying to prevent the heated objects causing fireworks by the use of metal of greater conductivity!

The placing of any metal in sheet form or strip on open element locking rings will almost certainly result in a blown fuse, if not the sudden death of the operator.

Yours faithfully,

Altrincham. J. STEBBINGS.

### Curved Flywheel Spokes

DEAR SIR,—I am interested to read the letter from Mr. W. J. Hughes, of Sheffield, in your issue of February 14th, and to know that curved spoke flywheels were fitted to certain steam engines. Traction engines are, of course, a subject and law unto themselves, and it is perfectly feasible that manufacturers possessing certain patterns for engine components would incorporate them in other engines of equivalent horsepower.

Mr. Hughes appears to have taken my "never" absolutely literally—though neither this, nor to be dogmatic was intended, as should be clear from the context of my letter. I had in mind large mill engine practice. I have no doubt patient search would produce a gas or an early oil engine with a straight-spoked flywheel, but this does not alter the truth of my statements, if regarded as indicative of general practice in the two fields.

As originally stated by Mr. Westbury, there was an element of ornament, or, I would say, fashion, in the use of curved spokes. It is perhaps noteworthy that the stone breaker manufacturers, faced with the problem of providing pairs of flywheels for their machines, comparable in size and weight to the medium powered i.c. engines, always appear to have favoured straight spokes.

I thank Mr. Hughes, therefore, for his observations, which, though literally correct, have not unfortunately contributed anything to the original point at issue, i.e. the reasons for curving the spokes of flywheels.

Yours faithfully,

Leicester. H. W. M. BECK.

### Electronic Organs

DEAR SIR,—In reply to Mr. Siddon's query *re* construction of an electronic organ, an article describing the construction of such an instrument was published in an American magazine, *Radio News*. The issues concerned were June and July, 1946. The operation of the instrument was on photo-electric lines and seems reasonably easy to construct. If Mr. Siddon is unable to obtain copies, I am quite prepared to loan him mine. Unfortunately, the mechanical details are only shown in photographs in the article; a drawing of the tone wheel pattern is given however, for photographic reproduction.

Yours faithfully,

Liverpool. A. FARNWORTH.

# CLUB ANNOUNCEMENTS

### The Bristol Society of Model and Experimental Engineers

On Wednesday, February 13th, 1952, at the Y.W.C.A., Great George Street, Bristol, the speaker was Mr. Pike, of British Railways, who gave members a talk on "Locomotive Maintenance."

As well as covering all aspects of routine maintenance, Mr. Pike's talk dealt with the correction of the many "snags" which occur, this being his special job he was well qualified to tell of it.

The talk was much enjoyed and when Mr. Pike asked for questions there were many of these and he dealt with them very thoroughly.

Hon. Secretary: F. C. WATTS, 7, Fifth Avenue, Northville, Filton, Bristol, 7.

### The Tees-side Society of Model and Experimental Engineers

At a recent meeting the chairman of the society, Dr. W. H. Maclennan, gave a talk entitled "Problems in Building a Miniature Locomotive," in which he described precise methods of dealing with machining, setting-out and lining-up the various details of a locomotive, and produced tools, jigs and measuring instruments used in such work. He described the use of the extremely useful "toolmaker's buttons" in setting out holes to be drilled precisely at a given distance apart.

His talk was enthusiastically received and promoted a lively discussion, especially as members have learned to value his advice in all technical matters concerning model engineering.

Hon. Secretary: J. W. CARTER, 28, East Avenue, Billingham, Co. Durham.

### Reading Society of Model and Experimental Engineers

The above society held their annual dinner and social recently at McIlroy's Restaurant, where 90 members and guests assembled to dine and listen to Chairman Bill Worrall's obituary on last year's events, and his entertaining discourse on "The Queer Attitude of Wives Toward Model Engineering."

Mr. J. N. Maskelyne said a few words about Co-Co, after which the gathering reassembled to see "Uncle" Goswell's film of club activities over the past year.

There followed a sketch, which depicted "The Queer Attitude of Wives Toward Model Engineering." (This appeared to be the main theme of the meeting.)

The "O" gauge section showed their superiority by exhibiting more models than the rest, and "OO" was conspicuous by its absence.

"Spud" Taylor's traction engine drew most attention, and an entertaining evening was enjoyed by all.

Hon. Secretary: J. SHAYLER, 14, Westwood Road, Tilehurst, Reading, Berks.

### The Model Engineering and Hobbies Club

At the recent annual general meeting held in the clubroom, it was seen that during the past twelve months the club had made much progress. We now have two small lathes and bench driller installed; also, a slow combustion stove had been fitted which adds considerable comfort to the clubroom.

The model locomotives under construction at present are $3\frac{1}{2}$-in. gauge *Vera* and *Tich*, gauge "1" *Wee Dot* and *Itichy* which is a narrow-gauge version of "Tich."

Three race cars are also being constructed, a 2 c.c. powered "Kitten," 1 c.c. own design, and 2 c.c. propeller-driven car.

Aircraft under construction are Supermarine "Attacker," Jetex-powered, and diesel-powered Miles "M.48."

On club nights (Wednesday and Saturday) there is always plenty of activity, as can be seen from the list of models being constructed. Much lively and helpful discussions are usually to be heard between members about methods and designs being worked out.

Hon. Secretary: R. JESSON, 129, Third Avenue, Bordesley, Birmingham, 9.

### Sutton Coldfield and North Birmingham Model Engineering Society

We shall be holding the follwing meetings at the Yenton Hotel, Sutton Coldfield:—

March 25th. Priestly Cup.
April 8th. Film night.
April 22nd. Annual general meeting.
May 6th. "Gas and its Uses."
May 20th. Radio control.
June 3rd. Open night.
June 17th. "Ships Models."

On February 26th a successful auction sale was held, and we were pleased to see our president back with us after his illness. The club will welcome visitors at any of their meetings.

Hon. Secretary: J. W. REVILL, 75, Churchill Road, Birmingham, 9.